



BC Hydro Conservation Potential Review 2002

Residential Sector Report
(Base Year: Fiscal 2000/01)

*Electricity Conservation Potential
in BC Hydro's Service Area*

May 2003

DOC
BC
B685
D:C667P6
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c.3

A03-253

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This is one of four reports developed for BC Hydro:

- **BC Hydro Conservation Potential Review 2002, Summary Report.**
Prepared by Polestar Communications Inc.
- **BC Hydro Conservation Potential Review 2002, Residential Sector Report.**
Prepared by Marbek Resource Consultants and The Sheltair Group Inc.
- **BC Hydro Conservation Potential Review 2002, Commercial Sector Report.**
Prepared by Marbek Resource Consultants
- **BC Hydro Conservation Potential Review 2002, Industrial Sector Report.**
Prepared by Marbek Resource Consultants and Willis Energy Services Ltd.

All the CPR 2002 Reports can be ordered at www.bchydro.com



**BC Hydro
Conservation Potential Review 2002**

**Residential Sector Report
(Base Year: Fiscal 2000/01)**

Submitted to:
BC Hydro

Prepared by:
**Marbek Resource Consultants
and
The Sheltair Group Inc.**

June 2003



ACKNOWLEDGEMENTS

Completion of the Conservation Potential Review 2002 on an accelerated time table is due in no small part to the consistent input from many BC Hydro staff members, as well as the hard work of the consultants engaged by BC Hydro.

Conservation Potential Review Core Group

The heaviest load fell on the Conservation Potential Review Core Group, which oversaw the management of the effort. The Group consisted of the following members:

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Many others reviewed draft reports and participated in periodic meetings and conference calls. These individuals included the following BC Hydro staff (all are from Power Smart, unless otherwise identified):

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External Review Panel

A number of organizations in BC also agreed to serve on an External Review Panel. They reviewed and commented on draft reports. However, their participation on the Panel should not be construed as indicating agreement with or endorsement of any of the Conservation Potential Review 2002 reports. Members of the Panel included the following:

- Canadian Home Builders' Association of B.C.
- B.C. Public Interest Advocacy Centre—Michael Doherty & Dick Gathercole
- Building Owners' and Managers' Association—Paul LaBranche
- Joint Industry Electric Steering Committee—Lorne Grasley, Dal Scott, Lisa Doig and Dan Potts
- Kootenay-Okanagan Electric Consumers' Association—Fred Marsh
- Pembina Institute for Appropriate Development—Roger Peters
- Sierra Club of B.C.—Tom Hackney, Bo Martin, and Michael Mascall
- David Suzuki Foundation—Dermot Foley
- Union of B.C. Indian Chiefs—David Hunt and Don Bain.

Consultants

The Conservation Potential Review 2002 was undertaken by a team of consultants headed by Marbek Resource Consultants, Ltd. of Ottawa, Ontario. The Residential Sector team included:

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Nancy J. Cooley (of Nancy J. Cooley & Associates: Embracing Change Creatively, Inc. of Victoria, B.C.) coordinated the Conservation Potential Review effort and provided day-to-day management, the contact point and interface for all participants.

EXECUTIVE SUMMARY

□ Background and Objectives

In 1991, BC Hydro launched the first collaborative study to estimate the potential for electricity conservation in a Canadian utility. The result was an in-depth analysis of where, how and at what cost electricity consumption in British Columbia (B.C.) could be reduced through electrical efficiency and behavioural changes. A decade later, continued provincial load growth as well as increasing environmental concerns had led to renewed interest in electrical efficiency and, in light of that interest, a decision was made to update the original Conservation Potential Review (CPR) in support of a new set of Power Smart initiatives. This study has been designed with a very tight time frame in order to meet Power Smart planning requirements.

The study had the following objectives:

- To provide BC Hydro's Power Smart program planners with an updated assessment of the remaining "hard-wired" electrical efficiency potential¹ in B.C. as a basis for designing new initiatives.
- To estimate the potential contribution of Power Smart efficiency programs to the reduction of BC Hydro's peak capacity requirements.
- To identify additional technologies that could become available to provide further savings over the study period.

□ Scope

It was originally envisioned that the entire scope of this study would directly follow the structure and approach of the original CPR. However, the context has altered significantly in the 10 years since the original CPR: electricity markets throughout North America have changed radically as a result of moves towards deregulation and privatization; better energy-use data for buildings, equipment and industrial processes are available; computer modelling tools for simulating energy use are more sophisticated; and, perhaps most importantly, North American utilities have an additional 10 years of experience in the design, promotion and implementation of DSM programs to draw upon. Consequently, with limited resources available, it was decided to focus on those areas that would best assist BC Hydro's Power Smart planners with the planning and design of new Power Smart initiatives. The intent was also to ensure that the results of this study have a good "shelf life" for Power Smart program and resource planning purposes.

Sector Coverage: This study addresses three sectors. The Residential Sector is covered in the present report; the Commercial and Industrial sectors are presented in separate documents.

¹ The focus was on "hard-wired" electrical efficiency measures; these types of measures are not dependant on repeated customer behaviour to be effective. From a utility's perspective they provide reliable and persistent savings.

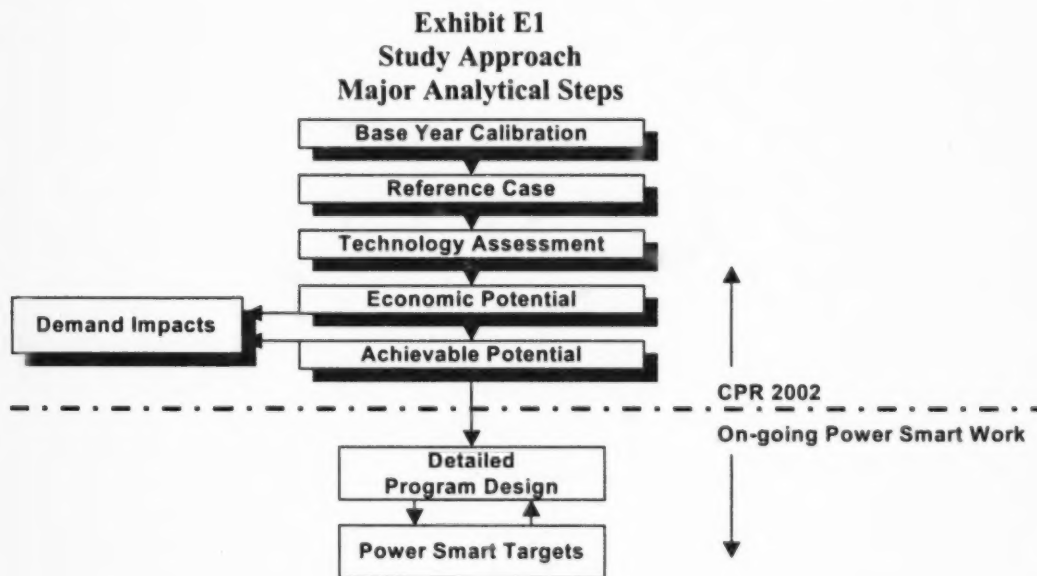
Geographical Coverage: The study results are presented for the total BC Hydro service area, excluding the (former) West Kootenay power service region. This study also provides the results for three regions (Lower Mainland, Vancouver Island and the Interior).²

Study Period: This study covers a 15-year period. The base year is the fiscal year (FY) 2000/01³, with milestone periods at 5-year increments: 2005/06, 2010/11 and 2015/16. The base year of fiscal year 2000/01 was selected as being the most recent 12-month period for which complete customer data were available.

Technologies: This study addresses all electrical efficiency technologies or measures that are expected to be commercially viable by the year 2005. Other technologies that control or shift electricity demand or that represent alternative sources of supply are outside of the scope of this study. The use of direct load control technologies is an example of the former group of excluded technologies whereas fuel switching to natural gas and the use of solar thermal or photovoltaic technologies provide examples of the latter group.

□ Approach

The detailed end-use analysis of electrical efficiency opportunities in the Residential Sector employed two linked modelling platforms, specifically: **HOT-2000**, a commercially supported, residential building energy-use simulation software; and **RSEEM** (Residential Sector Energy End-use Model), a Marbek in-house spreadsheet-based macro model (Exhibit E1).



² **Lower Mainland** includes the Lower Mainland of B.C., the Fraser Valley as far east as Hope, the Sunshine Coast and Powell River. **Vancouver Island** includes all of Vancouver Island plus those Gulf Islands that get their electricity supply from Vancouver Island. **Interior** includes the remainder of BC Hydro's service area. Areas that are not integrated into BC Hydro's grid are not included.

³ BC Hydro's fiscal year runs from April 1 to March 31.

The major steps involved in the analysis are shown in Exhibit E1 and are discussed in the following paragraphs. As illustrated, the results of this CPR study, and in particular the estimation of Achievable Potential, support on-going Power Smart work; however, it should be emphasized that the estimation of Achievable Potential is not synonymous with either the setting of specific Power Smart targets or with program design.

□ Major Analytic Steps and Definitions

This study employs numerous terms that are unique to analyses such as this one; below is a brief description of some of the most important terms. (Others are provided in the Glossary.)

Base Year Calibration The Base Year is the starting point for the analysis. It provides a detailed description of “where” and “how” electricity is currently used in the existing residential sector building stock. Building energy use simulations were undertaken for each of the major dwelling types and calibrated to actual BC Hydro customer billing data.

Reference Case (includes Natural Conservation) The Reference Case estimates the expected level of electricity consumption that would occur over the study period in the absence of new (post 2000/01) Power Smart initiatives. It provides the point of comparison for the subsequent calculation of “economic” and “achievable” electricity savings potentials. Creation of the Reference Case required the development of detailed profiles for new buildings in each of the dwelling types, estimation of the expected growth in building stock and appliances, and, finally an estimation of “natural” changes affecting electricity consumption over the study period. The Reference Case aligns well with BC Hydro’s December 2000 Load Forecast, which also incorporates “natural conservation” but no new Power Smart initiatives.

Technology Assessment Energy efficiency upgrade options were identified that met the criteria outlined above in the study’s scope. Technology cost and performance data were compiled relative to the base line technology and the Cost of Conserved Energy (CCE) was calculated for each upgrade option. The CCE is the annualized incremental capital and O&M cost of the upgrade measure divided by the annual savings achieved.

Economic Potential Forecast The Economic Potential Forecast is the level of electricity consumption that would occur if all appliances and building envelopes were upgraded to the level that is cost-effective, from BC Hydro’s perspective using life-cycle costing, against the long-run avoided cost of electricity in the BC Hydro service area, which in this study was set at \$0.06/kWh. All the electric energy-efficient upgrades included in the technology assessment that had a CCE⁴

⁴ The CCE is defined in Section 4 (4.1.1).

equal to, or less than, the avoided cost of new electricity supply (\$0.06/kWh) were incorporated into the Economic Potential Forecast.

Achievable Potential

The Achievable Potential is the proportion of the savings identified in the Economic Potential Forecast that could realistically be achieved within the study period. Achievable Potential recognizes that it is difficult to induce customers to purchase and install all the energy-efficient technologies that meet the criteria defined by the Economic Potential Forecast. The results are presented as a range, defined as "Most Likely" and "Upper".⁵

Estimates provided were developed in collaboration with Power Smart program personnel. They are based on a combination of empirical results from earlier Power Smart initiatives, results in other jurisdictions and a qualitative assessment of current market and customer receptivity to investments in energy efficiency. The range of estimates also recognize that in addition to factors within BC Hydro's control (e.g., program design), factors external to the utility (e.g., state of economy, Kyoto implications etc.) can significantly influence the Achievable Potential.

Demand Impacts

A methodology was developed to derive the on-peak demand impacts from the electricity consumption values contained in the Potential estimates noted above. In each case, the demand impacts report the reduction in BC Hydro's on-peak system generation requirements that would result from implementation of the energy-efficient measures included in each Potential estimate. For this study, BC Hydro's on-peak period was defined as weekdays from 6 a.m. to 10 p.m. during the months of December and January.

□ Results and Findings

A summary of the levels of annual electricity consumption contained in each of the preceding forecasts, by milestone year, is presented in Exhibits E2 and E3 and discussed briefly in the paragraphs below.

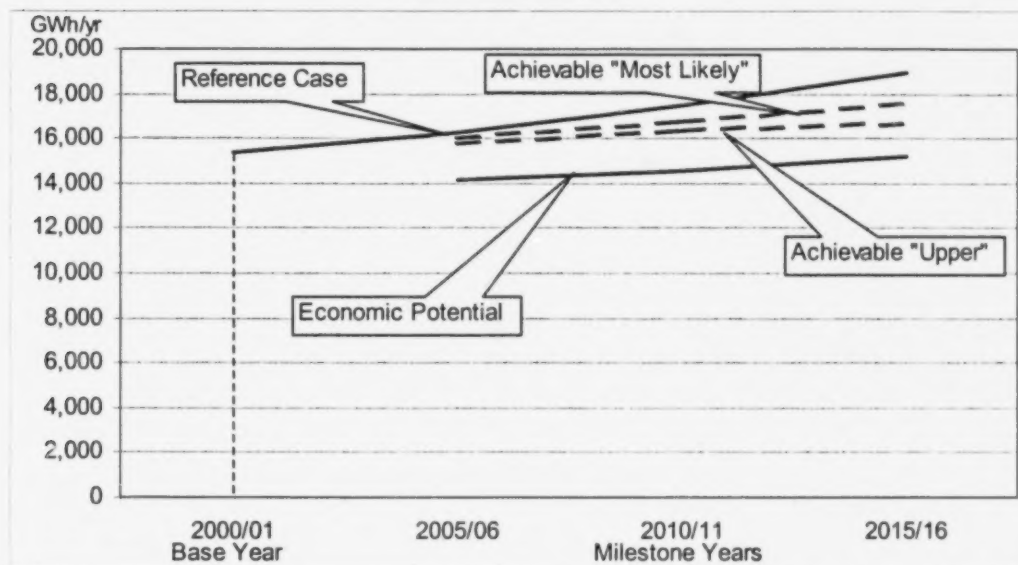
⁵ Definitions of the Achievable scenarios are provided in Section 6.2.

Exhibit E2
Summary of Forecast Results—Annual Electricity Consumption
Residential Sector, (GWh/yr.)

Annual Consumption (GWh/yr.) Residential Sector						Potential Annual Savings (GWh/yr.)		
Milestone Year	Base Year	Reference Case	Economic	Achievable		Economic	Achievable	
				Likely	Upper		Most Likely	Upper
2000/01	15,342	15,342						
2005/06		16,296	14,141	16,003	15,794	2,155	293	502
2010/11		17,497	14,546	16,778	16,313	2,951	719	1,184
2015/16		18,931	15,206	17,598	16,666	3,725	1,333	2,265

*Results are measured at the customer's point of use and do not include line losses.

Exhibit E3
Graphic of Forecast Results—Annual Electricity Consumption (GWh/yr.)
Residential Sector



Base Year Electricity Use and Calibration

In the base year of 2000/01, BC Hydro's residential sector consumed 15,342 GWh. Exhibit E4 shows that appliances used for food preparation (i.e., refrigeration, freezers, cooking, microwave ovens and dishwashers) account for approximately 21% of the total electricity use. Space heating accounts for about 20% of total residential electricity use,⁶ followed by lighting (17%). The "Other" end-use, which accounts for about 15% of electricity use, includes a variety of appliances ranging from coffee makers and toasters to whirlpools and spas.

⁶ Values are for all residential dwellings. Space heating share is much higher in electrically heated homes.

**Exhibit E4
Residential Sector
Base Year Electricity Use By End Use**

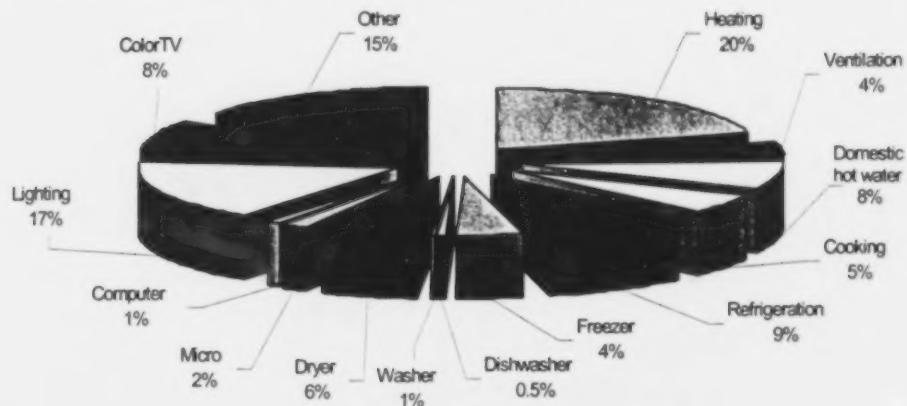
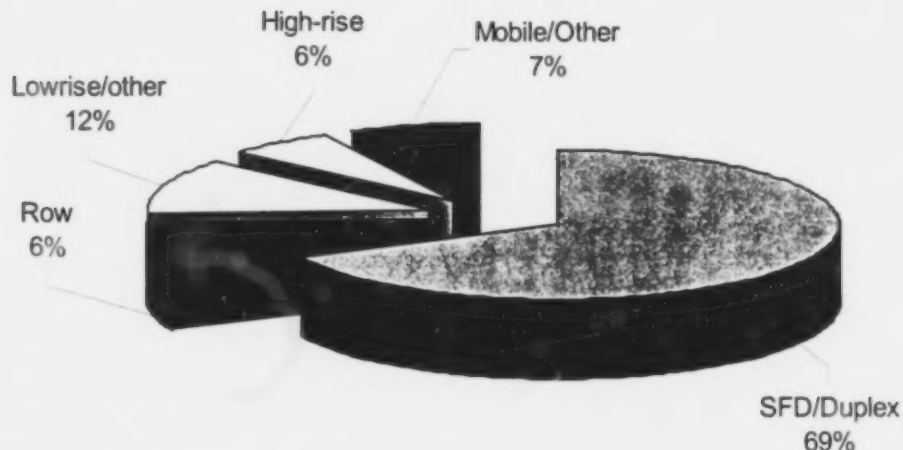


Exhibit E5 shows the distribution of base year electricity consumption by building segment. As illustrated, single-family detached (SFD)/duplex dwellings account for the largest share (69%) of residential base year electricity use.

**Exhibit E5
Residential Sector
Base Year Electricity Use By Building Segment**



Reference Case

In the absence of new Power Smart initiatives, the study estimates that electricity consumption in the Residential Sector will grow to 16,296 GWh/yr. by FY 2005/06, to FY 17,497 GWh/yr. by 2010/11 and 18,931 GWh/yr. by FY 2015/16. This represents an overall growth of about 23% in the period and compares very closely with BC Hydro's own December 2000 forecast which also includes consideration of the impacts of "natural conservation". Natural conservation is expected

to have most impact on kitchen and laundry appliance electricity use due to the continued market penetration of more efficient models into the residential appliance stock.

Economic Potential Forecast

Under the conditions of the Economic Potential Forecast, the study estimated that electricity consumption in the Residential Sector would grow to 15,206 GWh/yr. by FY 2015/16. Annual savings relative to the Reference Case are 3,725 GWh/yr. or about 20%. The Economic Potential annual savings in the intervening milestone years are 2,951 GWh/yr. and 2,155 GWh/yr. in FYs 2010/11 and 2005/06, respectively.

Achievable Potential

The electricity savings opportunities identified in the Economic Potential Forecast were "bundled", by end use, into a set of "Actions" reflecting a way in which initiatives may be undertaken. A brief profile was developed for each of the identified Actions. The Action Profiles provided a "high-level" logic framework that guided participant discussions in a full-day workshop as well as follow up meetings involving the consultant team and Power Smart personnel. The results are presented in Exhibit E6 by Action and by milestone year.

Consistent with the results in the Economic Potential Forecast, the most significant Achievable Savings opportunities were in the Actions that addressed lighting and appliances.

Exhibit E6
Summary of Achievable Savings for BC Hydro Service Area,
by Action and Milestone Year*

Action	Annual Electricity Savings by Milestone Year, (GWh/yr.)					
	2005/06		2010/11		2015/16	
	Most Likely	Upper	Most Likely	Upper	Most Likely	Upper
R1—Lighting	185	308	400	666	650	1,300
R2—Appliances	101	176	273	417	502	696
R3—Water Heating	1	2	1	2	2	4
R4—Efficient New Apartments	0	0	2	3	8	11
R5—Blower Motors	1	1	14	25	70	85
R6—Heat Pumps	1	2	3	5	6	12
R7—Weatherization	5	11	10	33	47	62
R8—Standby Losses	0	3	15	31	47	93
Totals	293	502	719	1,184	1,333	2,265

*Results are measured at the customer's point of use and do not include line losses.

Demand Impacts of Electrical Efficiency Measures

This study provided the first attempt by BC Hydro to estimate the demand impacts associated with the electrical efficiency measures incorporated in each of the preceding forecasts. This study did not focus *per se* on demand reduction, and the technology and load control strategies that would reduce peak capacity requirements lie beyond the scope of the present work. However, as illustrated in Exhibit E7, electricity savings contained in each of the forecasts have significant on-peak demand implications.

Relative to the Reference Case, on-peak demand savings in the Economic Potential Forecast are 427 MW in FY 2005/06, rising to 560 MW and 690 MW in FYs 2010/11 and 2015/16, respectively. Achievable Potential on-peak demand savings in FY 2005/06 range from 51 MW (Most Likely) to 88 MW (Upper), depending on scenario. By FY 2015/16 Achievable Potential on-peak demand savings range from 234 MW (Most Likely) to 398 MW (Upper), again depending on scenario.

**Exhibit E7
On-Peak Demand Savings
Residential Sector**

Milestone Year	Average On-peak Demand Residential Sector (MW)					Potential On-peak Demand Savings (MW)		
	Base Year	Reference Case	Economic	Achievable		Economic	Achievable	
				Most Likely	Upper		Most Likely	Upper
2000/01	2,664	2,664						
2005/06		2,843	2,415	2,792	2,755	427	51	88
2010/11		3,064	2,504	2,938	2,857	560	126	207
2015/16		3,323	2,633	3,089	2,925	690	234	398

□ Summary of Findings

The study findings confirm the existence of significant potential cost-effective electrical efficiency improvements in B.C.'s residential sector. In the "most likely" and "upper" achievable scenarios those electrical efficiency improvements would provide between 1,333 and 2,265 GWh/yr. of electricity savings by FY 2015/16 as well as on-peak demand savings of approximately 234 to 398 MW.

Lighting, followed by kitchen and laundry appliances represent the largest share of the identified savings potential.

Note: As in any study of this type, the results presented in this report are based on a number of important assumptions. Assumptions such as those related to the current penetration of efficient technologies and the rate of future growth in the stock of residential buildings are particularly influential. Wherever possible, the assumptions used in this study are consistent with those used by BC Hydro. However, the reader is referred to a number of caveats throughout the main text of the report.

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1. INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES

In 1991, BC Hydro launched the first collaborative utility process to estimate the potential for electricity conservation in a Canadian utility. A collaborative committee of electricity stakeholders oversaw the research, and the report presented an in-depth analysis of where, how and at what cost electricity consumption in British Columbia (B.C.) could be reduced through efficiency and behavioural changes.

A decade later, new pressures and structures in the industry are leading to renewed interest in conservation and load management. Increasing peak demands are encouraging consideration of demand-side management (DSM) as a means to defer transmission investment in certain areas. At the same time, BC Hydro's natural-gas-based generation plan identifies risks related to increased greenhouse gas emissions, risks that electrical efficiency can mitigate. There is also renewed interest in neighbouring jurisdictions in conservation as a means to mitigate the risk of price spikes and shortages in competitive markets. Since the original Conservation Potential Review (CPR), the performance efficiency of major electricity-using technologies has continued to improve, new products have become available in the market and additional technologies, based largely on advances in Information Technology (IT) and materials science, are under development: these will offer further improvement.

Given the above conditions, BC Hydro initiated the current study with the following objectives:

- To provide BC Hydro's Power Smart program planners with an updated assessment of the remaining "hard-wired" electrical efficiency potential⁷ in B.C. as a basis for designing new initiatives.
- To estimate the potential contribution of Power Smart efficiency programs to the reduction of BC Hydro's peak capacity requirements.
- To identify additional technologies that could become available to provide further savings over the study period.

1.2 STUDY SCOPE

It was originally envisioned that the entire scope of this study would directly follow the structure and approach of the original CPR. However, the context has altered significantly in the 10 years since the original CPR: electricity markets throughout North America have changed radically as a result of moves towards deregulation and privatization; better electricity-use data for buildings, equipment and industrial processes are available; computer modelling tools for simulating electricity use are more sophisticated; and, perhaps most importantly, North American utilities have an additional 10 years' experience in the design, promotion and implementation of DSM programs to draw upon. Consequently, with limited resources available, it was decided to focus

⁷ The focus was on "hard-wired" electrical efficiency measures; these types of measures are not dependant on repeated customer behaviour to be effective. From a utility's perspective they provide reliable and persistent savings.

on those areas that would best assist BC Hydro's Power Smart program planners with the design of new Power Smart initiatives. The intent was also to ensure that the results of this study have a good "shelf life" for Power Smart program and resource planning purposes.

The most significant changes to the original CPR scope that were introduced in this study are:

- **Focus is on economic potential.** The original CPR included estimates of unconstrained technical and social potential⁸ for electricity savings. While these potentials provided useful reference points at the time, the experience of the last 10 years has emphasized the importance of the economic potential⁹ as the basis for utility program planning.

The estimated potentials from the original CPR were intended to establish what the outside limits of conservation might be if one could get 100% of all the technological changes available and projected at the time and if one could get all customers to behave in the most electricity conserving manner. When BC Hydro decided to update its estimates, it was more interested in how much of the remaining potential could be realistically achieved through renewed investment in DSM rather than what could be achieved through customers changing their behaviour. Consequently, this CPR focuses on economic potential and primarily on so called "hard-wired" options (those that are little or not at all affected by customer behaviour). The resulting potential estimates should, therefore, be read as a reasonable estimate of what BC Hydro could target with new Power Smart programs. Unlike the original CPR estimates, it cannot be read as an estimate of what the potential pool of conserved electric energy could be. Clearly, the latter is much larger than this CPR would indicate, since it would contain the effects of: changes in customer attitude and behaviour; changes in electricity rate structures; and changes in provincial and/or federal government policies and programs with respect to electricity.

- **Electricity savings are calculated relative to a Reference Case that includes natural conservation.** The original CPR calculated electricity savings on the basis of a frozen efficiency forecast (i.e., "no efficiency improvements"). However, this frozen efficiency forecast is not as relevant today, as electrical efficiency improvements have gained a momentum of their own and continue to be promoted by a variety of public- and private-sector proponents.
- **The demand impacts of the electrical efficiency measures are estimated.** Demand was not addressed in the original CPR; however, demand constraints have become a more important concern to BC Hydro than at the time of the original CPR. Consequently, this CPR includes an estimate of the demand reductions that would occur as a result of the electrical efficiency savings contained in the study. (Note: specific load control or load-shifting measures are not included within the study scope.)

⁸ The social potential that was included in the original CPR included attitude and behavioural changes such as turning off lights.

⁹ The original CPR also attempted to quantify *all* technologies that were expected to become "economic" by the end of the study period. The current CPR set the first milestone year of 2005 as the economic cut-off date for quantitative inclusion of technologies in the economic potential forecast. This study does identify additional technologies that may become economic between 2005 and the end of the study period, but does not attempt to quantify their potential savings contribution.

With the exception of the above changes, the scope of this CPR remains largely unchanged from the 1991 study. More specifically:

- **Sector Coverage:** This study addresses the same three sectors: Residential, which is covered in the present report; and Commercial and Industrial, which are addressed in separate documents. As in the original CPR, street lighting is not included.
- **Geographical Coverage:** The study results are presented for the total BC Hydro service area but exclude, as in the original CPR, the (former) West Kootenay Power service region. In contrast to the original CPR, this study also provides the results for three regions (Lower Mainland, Vancouver Island and the Interior).¹⁰
- **Study Period:** This study also covers a 15-year period. The base year is the fiscal year (FY) 2000/01, with milestone periods at 5-year increments: 2005/06, 2010/11 and 2015/16. The base year of fiscal year 2000/01 was selected, as this was the most recent 12-month period for which complete customer data were available.
- **Technologies:** This study addresses all electrical efficiency technologies or measures that are expected to be commercially viable by the year 2005. A summary of the technologies and measures included in this study is provided in Exhibit 1.1.

Other technologies that control or shift demand for electricity or represent alternative sources of energy supply are outside of the scope of this study. The use of direct load control technologies is an example of the former group of excluded technologies while fuel switching to natural gas and the use of solar thermal or photovoltaic technologies provide examples of the latter group.

Exhibit 1.1 also shows whether the selected technologies and measures are addressed in the "core" analysis or if they are an emerging technology. The "core" technologies are incorporated in the main analysis. The technologies noted in the "emerging" column of Exhibit 1.1 have not yet reached the point of full commercialization; nonetheless, it is recognized that they could become commercially available in the period. These latter technologies are addressed separately in Section 8 and their potential contribution to further electricity savings over the study period is briefly noted.

¹⁰ **Lower Mainland** includes the Lower Mainland of B.C., the Fraser Valley as far east as Hope, the Sunshine Coast and Powell River. **Vancouver Island** includes all of Vancouver Island plus those Gulf Islands that get their electricity supply from Vancouver Island. **Interior** includes the remainder of BC Hydro's service area. Areas that are not integrated into BC Hydro's grid are not included.

Exhibit 1.1: Residential Sector Technologies and Measures Included in Study

End Use	Efficient Technologies	Core Analysis	Emerging Technologies (see Section 8)
Lighting	High-efficiency T8 Lamps	X	
	Compact Fluorescents	X	
	Two-Photon Lighting		X
	LED Holiday Lights	X	
	White LED	X	
Building Envelope	Gas-filled Insulation Panels	X	
	Vacuum Insulation Panels	X	
	Phase Change Wallboard	X	
	Aerogel Glazings		X
	Crawl Space Insulation	X	
	Air Leakage Sealing	X	
	High-performance Glazings	X	
Heating/Cooling	Temperature Setback	X	
	Cold-climate Heat Pumps	X	
	Advanced WLHP controls	X	
	Efficient Furnace Fan Motor	X	
	Ground Source Heat Pump	X	
	Magnetic Refrigeration (A/C)		X
Ventilation	ECMP fan motors	X	
Domestic Hot Water	Efficient Shower/Faucet	X	
	Heat Traps	X	
	Heat Pump Water Heater	X	
	Improved Tank Insulation	X	
Appliances	Horizontal Axis Cl. Washer	X	
	Efficient Top Load Cl. Washer	X	
	Efficient Dishwasher	X	
	High-efficiency Refrigerator	X	
	Gen 2 Refrigerator (magnetic, thermo-acoustic, linear compressor)		X
	High-efficiency Freezer	X	
	Gen 2 Freezer (magnetic, thermo-acoustic, linear compressor)		X
	Microwave Clothes Dryer	X	
	High-efficiency Microwave/Convection Oven	X	
Plug in Equipment	Reduced Standby for Computers	X	
	LCD Monitors	X	
	Miscellaneous Reduced Standby (DVDs, TVs, VCRs)	X	
Building Design	Advanced Housing Design	X	
	Integrated Design Approach for Apartments	X	

1.3 DEFINITIONS

This study employs numerous terms that are unique to analyses such as this one and consequently it is important to ensure that all readers have a clear understanding of what each term means when applied to this study. Below is a brief description of some of the most important terms. The reader is also referred to the Glossary of Terms, which is found in Section 11 of this report. Key terms include:

- Base Year Calibration** The Base Year is the starting point for the analysis. It provides a detailed description of “where” and “how” electricity is currently used in the existing residential sector building stock. Building electricity use simulations were undertaken for each of the major dwelling types and calibrated to actual BC Hydro customer billing data.
- Reference Case
(includes Natural Conservation)** The Reference Case estimates the expected level of electricity consumption that would occur over the study period in the absence of new (post 2000/01) Power Smart initiatives. It provides the point of comparison for the subsequent calculation of “economic” and “achievable” electricity savings potentials. Creation of the Reference Case required the development of detailed profiles for new buildings in each of the dwelling types, estimation of the expected growth in building stock and appliances, and, finally an estimation of “natural” changes affecting electricity consumption over the study period. The Reference Case aligns well with BC Hydro’s December 2000 Load Forecast, which also incorporates “natural conservation” but no new Power Smart initiatives.
- Technology Assessment** Energy efficiency upgrade options were identified that met the criteria, as outlined above in the study’s scope. Technology cost and performance data were compiled relative to the base line technology; as applicable, “market-mature” product prices were estimated for new technologies currently entering the market. The Cost of Conserved Energy (CCE) was then calculated for each upgrade option. The CCE is the annualized incremental capital and O&M cost of the upgrade measure divided by the annual savings achieved.
- Economic Potential Forecast** The Economic Potential Forecast is the level of electricity consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost-effective against the long-run avoided cost of electricity in the BC Hydro service area, which in this study was set at \$0.06/kWh. All the electric energy-efficient upgrades included in the technology assessment that had a CCE equal to, or less than, the avoided cost of new electricity supply (\$0.06/kWh) were incorporated into the Economic Potential Forecast.
- Achievable Potential** The Achievable Potential is the proportion of the savings identified in the Economic Potential Forecast that could realistically be achieved within the study period. Achievable Potential recognizes that it is difficult to induce customers to purchase and install all the electrical efficiency technologies that meet the criteria defined by the Economic Potential Forecast. The results are presented as a range, defined as “Most Likely” and “Upper”.

Estimates provided were developed in collaboration with Power Smart program personnel; they are based on a combination of empirical results from earlier Power Smart initiatives, results in other jurisdictions and a qualitative assessment of current market and customer receptivity to electrical efficiency investments. The range of estimates also recognizes that in addition to factors within BC Hydro's control (e.g., program design), factors external to the utility (e.g., state of economy, Kyoto implications etc.) can significantly influence the Achievable Potential.

Demand Impacts

A methodology was developed to derive the on-peak demand impacts from the electricity consumption values contained in the Potential estimates noted above. In each case, the demand impacts report the reduction in BC Hydro's on-peak system generation requirements that would result from implementation of the electrical efficiency measures included in each Potential estimate. For this study, BC Hydro's on-peak period was defined as weekdays from 6 a.m. to 10 p.m. during the months of December and January

1.4 OVERVIEW OF APPROACH

To meet the objectives outlined above, the study was conducted within a highly iterative process that involved a number of well defined steps. At the completion of each step, the client¹¹ reviewed the results and, as applicable, revisions were identified and incorporated into the interim results. The study then progressed to the next step. A summary of the steps is presented below.

Step 1: Develop Base Year Calibration Using Actual BC Hydro Billing Data

- Compile and analyze available data on B.C.'s existing building stock.
- Develop detailed technical descriptions of the existing building stock.
- Undertake computer simulations of electricity use in each building type and compare these with actual building billing and audit data.
- Compile actual BC Hydro billing data.
- Create sector model inputs and generate results.
- Calibrate sector model results using actual utility billing data.

Step 2: Develop Reference Case

- Compile and analyze building design, equipment and operations data and develop detailed technical descriptions of the new building stock.
- Develop computer simulations of electricity use in each new building type.
- Compile data on forecast levels of building stock growth and "natural" changes in equipment efficiency levels and/or practices.
- Define sector model inputs and create forecasts of electricity use for each of the milestone years.
- Compare sector model results with BC Hydro's "basic" forecast for period.

¹¹ Members of the External Review Panel also read and commented on draft reports, and participated in aspects of the study.

Step 3: Develop and Assess Energy Efficiency Upgrade Options

- Develop list of electrical efficiency measures.
- Compile detailed cost and performance data for each measure.
- Identify the baseline technologies employed in the Reference Case.
- Develop energy efficiency upgrade options for each end use.
- Determine the Cost of Conserved Energy (CCE)¹² for each upgrade option.

Step 4: Estimate Economic Electricity Savings Potential

- Compile utility economic data on the forecast cost of new electricity generation; a cost of \$0.06/kWh was selected, based on the assumption that new electricity would be supplied by combined cycle gas-fired generation.¹³
- Screen the identified energy efficiency upgrade options from Step 3 against the utility economic data.
- Identify the combinations of energy efficiency upgrade options and building types where the cost of saving a kilowatt of electricity is equal to, or less than, the cost of new electricity generation.
- Apply the economically attractive electrical efficiency measures from Step 3 within the energy use simulation model developed previously for each building type.
- Determine annual electricity consumption in each building type when the economic efficiency measures are employed.
- Compare the electricity consumption levels when all economic efficiency measures are used with the Reference Case consumption levels and calculate the electricity savings.

Step 5: Estimate Achievable Electricity Savings Potential

- “Bundle” the electricity saving opportunities identified in the Economic Potential Forecast into a set of Actions.
- Create “Action Profiles” for each of the identified Actions that provide a “high-level” rationale and direction, including target technologies and sub-markets as well as key barriers and a broad intervention strategy.
- Review historical achievable program results and prepare preliminary Action Assessment Worksheets.
- Consult with Power Smart personnel, review preliminary estimates and reach general agreement on “most likely” and “upper” range of achievable potential.

Step 6: Estimate Demand Impacts of Economic and Achievable Electricity Savings Potential

- Define utility peak periods and estimate the distribution of base year annual electricity use within each period, based on best available load data.

¹² The term CCE that is used in this study refers to the same methodology as was used in the original CPR. However, in the original CPR, the term Total Resource Cost (TRC) was used. In both CPRs program and administrative costs were excluded. Since the TRC normally includes program and administrative costs, it was considered clearer to use the term Cost of Conserved Energy in this effort. Adding 0.5 to 1 cent per kilowatt hour to the CCE used in this review would give a rough approximation of the TRC as it is usually calculated. Further detail on the CCE is provided in Section 4 (4.1.1).

¹³ Further discussion of the cost of new electricity generation is provided in Section 5.2.

- Compare demand estimates with best available utility system and sector load data.
- Using the same approach as for the estimate of base year, calculate average on-peak demand for the Reference Case as well as Economic Potential and Achievable Potential Forecasts.
- Calculate on-peak demand savings for the Economic and Achievable Potential Forecasts relative to the Reference Case.

Step 7: Review Additional Technologies

- A brief qualitative write up was prepared for those technologies that did not meet the study criteria for inclusion but could, nonetheless, provide additional savings under the appropriate conditions.

1.5 ANALYTICAL MODELS

The analysis of the Residential Sector employed two linked modelling platforms as follows:

- **HOT-2000**, a commercially supported, residential building energy-use simulation software; and
- **RSEEM** (Residential Sector Energy End-use Model), a Marbek in-house spreadsheet-based macro model.

HOT-2000 was used to define household heating, cooling and domestic hot water (DHW) electricity use for each of the residential building archetypes. HOT-2000 uses state-of-the-art heat loss/gain and system modelling algorithms to calculate household electricity use. It addresses:

- Electric, natural gas, oil, propane and wood space heating systems;
- DHW systems from conventional to high-efficiency condensing systems; and
- The interaction effect between space heating appliances and non-space heating appliances, such as lights and refrigerators.

The outputs from HOT-2000 provide the space heating/cooling energy-use intensity (EUI) inputs for the Thermal Archetype module of RSEEM.

RSEEM consists of three modules:

- A General Parameters module that contains general sector data (e.g., number of dwellings, growth rates, etc.);
- A Thermal Archetype module, as noted above, that contains data on the heating and cooling loads in each archetype; and
- An Appliance Module that contains data on appliance saturation levels, fuel shares, unit electricity use, etc.

RSEEM combines the data from each of the modules and provides total use of electricity by service region, dwelling type and end use. RSEEM also enables the analyst to estimate the impacts of the electrical efficiency measures on the utility's on-peak system demand.

1.6 REPORT PRESENTATION

The remainder of this report is organized as follows:

- **Section 2** presents the results of and the specific tasks involved in developing the base year calibration.
- **Section 3** presents the Residential Reference Case for the FYs 2000/01 to 2015/16.
- **Section 4** identifies and assesses technical options for improving electrical efficiency within the Residential Sector.
- **Section 5** presents the Residential Sector Economic Potential Forecast for the study period (FYs 2000/01 to 2015/16).
- **Section 6** estimates the proportion of savings identified in the Economic Potential Forecast that can realistically be achieved within the study period.
- **Section 7** estimates the demand impacts of the Economic Potential Forecast.
- **Section 8** provides a qualitative review of selected additional technologies that could provide additional electricity savings over the study period.
- **Section 9** summarizes the key study findings.
- **Section 10** lists sources and references.
- **Section 11** presents a glossary of terms used throughout this study.

2. BASE YEAR CALIBRATION, RESIDENTIAL SECTOR

2.1 INTRODUCTION

This section presents results of the Base Year calibration. The discussion is organized into the following subsections:

- Segmentation of Base Year Housing Stock
- Estimation of Net Space Heating Loads
- Annual Appliance Electricity Use
- Appliance Saturation
- Electricity Fuel Share
- Average Electricity Use Per Unit
- Summary of Model Results
- Comparison with BC Hydro Billing Data.

2.2 SEGMENTATION OF HOUSING STOCK

The first major task in developing the base year electricity consumption involved the segmentation of the residential building stock on the basis of four factors:

- Dwelling type or building segment;
- Vintage;
- Heating category (electrically heated versus non-electrically heated); and
- Service area.

As agreed at the study's outset, the dwelling types used in the analysis are as follows:

- Single-family Detached/Duplex (including all detached single-family dwellings and duplexes);
- Row (including all row houses and townhouses);
- Low-rise Apartment (four storeys or less);
- High-rise Apartment (five storeys or more); and
- Mobile/Other.

BC Hydro customer billing data were used to develop a breakdown of the Residential Sector by dwelling type. This information is summarized in Exhibit 2.1. As can be seen, BC Hydro currently services about 1.4 million dwelling units. On a regional basis, almost 60% of BC Hydro customers are in the Lower Mainland region, with 20% of customers in each of the Vancouver Island and Interior regions. On a basis of dwelling type, 56% of the residential stock is single-family, and a further 20% of the residential stock is low-rise apartment. In terms of fuel share, 21% of the residential stock uses electricity for the primary space heating fuel; however, in the Vancouver Island region, electric space heating serves 40% of the stock.

Estimating the number of dwelling units was relatively straightforward for single, row and mobile homes, as BC Hydro customer account data correspond quite well to the number of units. However, estimating the number of apartment units was more difficult, as there is a significant number of "single-meter" apartment buildings.

The following subsection provides further detail on the method and assumptions used to estimate the number of low- and high-rise apartment units and to determine the split between suite and corridor electricity use.

Exhibit 2.1: Existing Residential Units for Total BC Hydro Service Area by Segment, Vintage and Primary Heating Source, 2001

Segment	Units			
	Lower Mainland	Vancouver Island	Interior	Total
Single-family/Duplex Dwelling, Non-electric Heating	403,033	105,418	154,166	662,617
Single-family/Duplex Dwelling, Pre 1976, Electric Heating	6,074	17,694	11,661	35,429
Single-family/Duplex Dwelling, Post 1976, Electric Heating	18,381	65,737	21,868	105,986
Row, Non-electric Heating	52,430	8,805	6,700	67,935
Row, Pre 1976, Electric Heating	1,585	2,349	1,435	5,369
Row, Post 1976, Electric Heating	24,411	4,462	2,201	31,074
Low-rise Apartment Units, Non-electric Heating	153,600	35,500	29,900	219,000
Low-rise Apartment Units, Electric Heating	45,200	19,900	7,500	72,600
High-rise Apartment Units, Non-electric Heating	76,700	13,700	8,267	98,667
High-rise Apartment Units, Electric Heating	23,100	3,600	3,714	30,414
Mobile, Non-electric Heating	20,960	17,897	48,559	87,416
Mobile, Electric Heating	3,695	6,067	5,091	14,853
Subtotal	829,169	301,129	301,062	1,431,360

Source: BC Hydro customer billing data.

2.2.1 Calculation of Apartment Units

The number of apartment units was estimated on the basis of BC Hydro's database of 9,600 "clear"¹⁴ apartments. The database was used first to determine the split between suite and corridor/common area electricity consumption: based on the data provided, corridors and common areas were estimated to account for about 30% of total consumption. The splits and consumption values for individual suites were defined so that the average consumption per suite approximated the average suite consumption from the BC Hydro database of 9,600 apartments. Space heating loads were estimated from

¹⁴ "Clear" refers to apartment buildings in which individual apartment units as well as corridor/common areas are metered separately.

analysis of the monthly sales consumption for winter weather-sensitive conditions. The consumption per suite was derived through the building electricity use simulation modelling.

Once the corridor/common area and individual suite consumption values were established for both electrically and non-electrically heated units, the number of suites for the whole service area was estimated by dividing the actual apartment billing data by the modelled suite electricity consumption.

2.3 ESTIMATION OF NET SPACE HEATING LOADS

The net space heating loads¹⁵ for single, row and mobile units were developed using HOT-2000 simulations of archetypal buildings.¹⁶ Building archetypes were developed using a 2,800-building database developed from the EnerGuide for Houses program. The EnerGuide database provides detailed descriptions of building areas and volume, airtightness and thermal characteristics of floors, windows, doors, ceilings and walls.

A brief discussion of some of the most important variables affecting the net space heating loads in BC's residential stock is presented below.

2.3.1 Envelope Area and Exposure

Attachment type is the main influence on building envelope area and exposure of buildings. Moving from greatest exposure to least, dwelling types include mobile homes, single-family, duplex, townhouse or row, and low- and high-rise apartments. Duplexes are built in a similar fashion to single-family homes but, from an exposure perspective, are more similar to row houses. Townhouses, which also share one or two walls, are on average smaller than single-family detached dwellings.

2.3.2 Climate

B.C. has a far greater diversity of climatic types than any other region in Canada, which creates a unique situation when it comes to defining building types. The simplest division on a climatic basis is between the coastal areas and the interior. Approximately 80% of the residential stock in B.C. is located in the coastal areas, including Vancouver Island and the Lower Mainland. The remainder is spread out over the interior where the climate is similar to that of northern Canada and the Prairies. In general, this climatic divide results in major variations in the size, structure and thermal performance of buildings. For data analysis purposes, however, it was necessary to work with the regions that BC Hydro had already established for customer accounts. In general, the coastal climate corresponds to BC Hydro's Lower Mainland and Vancouver Island regions. The cold interior climate corresponds to the Northern Region and Southern Interior. The poorest fit is in the northern coastal area, where BC Hydro groups larger communities, such as Prince Rupert and Terrace, with the much colder communities of the interior. For

¹⁵ Net space heating load is the space heating load of a building that must be met by the space heating system. This is equal to the total heat loss through the building envelope minus solar and internal gains.

¹⁶ Due to the greater complexity of low- and high-rise apartments, their net space heat loads were modelled using Marbek's commercial building energy simulation model.

modelling purposes, weather data from Vancouver, Victoria and Kamloops were used to create thermal simulations of the Lower Mainland, Vancouver Island and Interior regions, respectively.

2.3.3 Floor Area and Shape

Exhibit 2.2 presents the typical floor area by region and vintage for single-family houses. As can be seen, there has been a general increase in floor area over time, and houses in the Lower Mainland are generally larger than those in the Vancouver Island and Interior regions. The biggest changes in housing size have occurred since the mid-1980s, when changing demographics and growing affluence resulted in larger floor areas for new houses.

The shapes of houses have also changed over the years, as they have in other Canadian provinces. Pre-1970 houses typically have half-storeys and simple floor plans. Post-1970 houses are most likely to include split-levels, ranchers and two-storey houses, with more complex floor plans. As a result, newer houses generally have more wall area. Finally, due to the improved performance of newer windows, the area of glazing has increased by about 15%.

Exhibit 2.2: Typical Floor Areas for Single-family Detached Dwellings by Vintage and Region, (sq. ft.)

Vintage	Floor Space including basement area, (sq. ft.)		
	Lower Mainland	Vancouver Island	Interior
Pre-1965	2335	2400	2335
1966-1985	2540	2280	2520
1986-2000	3260	2700	2850
Number in sample	1,470 dwellings	466 dwellings	876 dwellings

Source: BC EnerGuide for Houses database.

2.3.4 Basement Style

Basement style also affects space heating consumption. For example, full basements (e.g., ceiling height of 7 to 8 ft.) result in greater exterior wall area and room volume that require heating than, say, a crawlspace, where ceiling heights are typically 4 ft. or less.

An analysis of basement detachment styles was completed using the EnerGuide for Houses database and the results are shown in Exhibit 2.3. As illustrated, single-family dwellings in all regions of BC typically combine more than 1 basement style.

Exhibit 2.3: Type of Basement for Single-family Detached Dwellings by Region

Region	Incidence of Basement Styles/Dwelling (%)				Ave. Styles per Dwelling
	Exposed/Crawl	Slab	Shallow	Full	
Lower Mainland	61	63	83	44	2.49
Vancouver Island	63	63	85	34	2.45
Interior	55	61	75	77	2.65

Source: BC EnerGuide for Houses database.

2.3.5 Airtightness

Air test data for single-family houses were measured as part of the EnerGuide for Houses program, and Exhibit 2.4 summarizes results by vintage and region. As demonstrated, there has been a continual improvement in the airtightness of buildings in all regions, with the most airtight houses located in the Interior region.

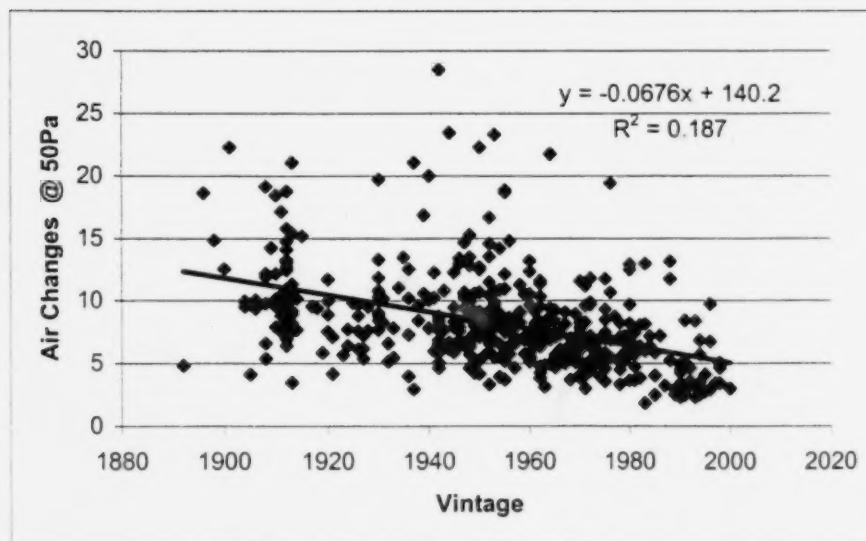
Exhibit 2.4: Average Air Changes per Hour in Single-family Detached Dwellings by Vintage and Region, (ACH @ 50 Pa)

Vintage	Lower Mainland (ACH)	Vancouver Island (ACH)	Interior (ACH)
Pre-1965	10.5	9.27	6.81
1966-1985	8.55	6.80	5.24
1986-2000	5.58	4.59	4.07
Number in sample	1470 dwellings	466 dwellings	876 dwellings

Source: BC EnerGuide for Houses database.

Exhibit 2.5 is a scatter plot showing improvement in the airtightness of building envelopes for single-family houses located on Vancouver Island. As demonstrated, there has been a continued improvement in the performance of air barriers over time.

Exhibit 2.5: Average Air Changes per Hour for Single-family Detached Dwellings by Vintage on Vancouver Island, (ACH @ 50 Pa)



Source: BC EnerGuide for Houses database.

2.3.6 Heating Set Point

The assumptions made relating to heating set points throughout a dwelling affect the calculation of net space heating load. Exhibit 2.6 summarizes the set points employed in the HOT-2000 simulations. As demonstrated, electrically heated buildings are assumed to have a slightly lower set point temperature to reflect the greater use of zoned heating systems in electrically heated, compared to non-electrically heated, dwellings.

Exhibit 2.6: Heating Set Points,¹⁷ (°C)

Heat	Single		Duplex		Row		Apartment		Mobile/ Other
Type	Main	Basement	Main	Basement	Main	Basement	Suite	Corridor	Main
Electric	18.0	16.0	18.0	16.0	18.0	16.0	20	17	18.0
Non-elec.	19.0	17.0	19.0	17.0	19.0	17.0	20	17	19.0

2.3.7 Net Space Heating Load

Exhibit 2.7 summarizes the net space heating load by type of detachment, vintage and location. These estimates refer to the load that the space heating system must meet. In the case of non-electrically heated dwellings, the estimate refers to the required output from the heating system. Values for non-electrically heated dwellings are included in Exhibit 2.7 as a portion of this heat load is met by supplemental electric heat.

For ease of interpretation, the total apartment space heating load has been disaggregated to distinguish the heating load for suites from the heating load for common areas, such as corridors and lobbies. For presentation purposes, the net heat loads that Exhibit 2.7 shows for apartment corridors/common areas relate to the whole building.

¹⁷ The heating set points appear to be in the low range; however, these levels were necessary to ensure that the HOT-2000 model results calibrated with the results of BC Hydro's conditional demand analysis.

Exhibit 2.7: Existing Residential Units—Net Space Heating Loads¹⁸ by Building Segment and BC Hydro Service Region, (kWh/yr.)*

Segment	Net Space Heating Load		
	Lower Mainland	Vancouver Island	Interior
Single-family/Duplex Dwelling, Non-electric Heating	12,654	11,044	13,500
Single-family/Duplex Dwelling, Pre 1976, Electric Heating	13,223	11,967	14,446
Single-family/Duplex Dwelling, Post 1976, Electric Heating	10,655	9,773	12,219
Row, Non-electric Heating	6,879	6,571	7,200
Row, Pre 1976, Electric Heating	5,665	5,574	6,250
Row, Post 1976, Electric Heating	4,600	4,555	5,536
Low-rise Apartment Units, Non-electric Heating	2,800	2,750	3,000
Low-rise Apartment, Non-electric Heating, Whole Building Corridor	36,360	36,500	23,600
Low-rise Apartment Units, Electric Heating	2,800	2,700	3,000
Low-rise Apartment, Electric Heating, Whole Building Corridor	36,360	27,000	23,600
High-rise Apartment Units, Non-electric Heating	2,700	2,700	2,750
High-rise Apartment, Non-electric Heating, Whole Building Corridor	208,000	169,400	133,600
High-rise Apartment Units, Electric Heating	2,700	2,600	2,750
High-rise Apartment, Electric Heating, Whole Building Corridor	208,000	80,780	165,400
Mobile, Non-electric Heating	7,000	7,000	8,459
Mobile, Electric Heating	7,000	7,000	8,459

* kWh/yr. = kilowatt hours per year.

¹⁸ Net space heating load is the space heating load of a building that must be met by the space heating system over a full year. This is equal to the total heat loss through the building envelope minus solar and internal gains. Values shown for non-electrically heating dwellings are shown in kilowatt hours for format consistency.

2.3.8 Supplemental Heating

The use of supplemental heating in residential dwellings is a dynamic process shaped by a number of factors. During the 1970s and '80s, a small percentage of houses in B.C. were converted to electric heating from other fuels. This occurred primarily on Vancouver Island, either as part of the Electric Plus program, or as a result of the federal government's Canadian Oil Substitution Program (COSP). These conversions had the effect of increasing the numbers of older housing stock with electric heat. A fraction of 1940s and '50s housing with uninsulated walls and foundations was converted to electric heating.

During the mid-1980s, low-temperature radiant electric heating once again became popular. In a number of fast-growing subdivisions in the Lower Mainland area, electric heating was combined with forced-air gas furnaces. This hybrid system was popular because of easy installation and low capital cost. A gas-fueled forced-air system was installed in the crawl space and main floor portions of the house, and electric baseboards were installed upstairs. This avoided the requirement for ducting up to the second storey, and the trades promoted it on the basis that "heat rises," and therefore the electric heating was simply a backup for coldest weather.

More recently, rapid increases in the cost of natural gas and propane fuels have resulted in significant increases in the use of portable electric resistance heaters during periods of higher priced fossil fuels.¹⁹

In addition to fuel conversions and substitutions, there is a large number of home renovations and additions that have involved the installation of electric space heating in previously non-electrically heated houses. Electric baseboards are a convenient, low first-cost installation for a new room in an existing house. Presumably this phenomenon has been occurring since the mid-1960's and growing in proportion to the rapidly increasing rates of renovation and addition-building in the 1970's and '80's. Many of these renovations produced illegal suites, which are rented out. This results in additional electricity being used on a single meter.

The results of BC Hydro's *Residential End Use Survey* (REUS) show the incidence of supplemental heating equipment in both non-electrically heated and electrically heated dwellings, as illustrated in Exhibits 2.8 and 2.9. As demonstrated, the existence of electric supplemental heating equipment ranges from 21% to 63% for non-electrically heated dwellings. Similarly, in electrically heated dwellings, as much as 76% of the stock has non-electric supplemental heating equipment. Unfortunately, these data only show the incidence of each type of heating equipment; they do not tell how much space heat is actually provided by the equipment. This makes the calculation of actual electric heat contribution more difficult.²⁰ (The amount of space heat provided by supplemental heating systems is resolved in Section 2.6, which discusses electric fuel shares.)

¹⁹ Personal communications with major BC home improvement retail outlets.

²⁰ In an attempt to address this data gap, natural gas billing data were requested for a sample of electrically and non-electrically heated homes. However, it was not possible to obtain the data within the time constraints of this study.

Exhibit 2.8: Supplemental Electric Heating Equipment in Non-electrically Heated Dwellings, (%)

Segment	Incidence of Supplemental Electric Heating Equipment (%)		
	Lower Mainland	Vancouver Island	Interior
Single-family	38	52	37
Duplex	32	36	26
Row	39	63	29
Apartment	23	31	21
Mobile/Other	38	31	35

Exhibit 2.9: Supplemental Non-electric Space Heating Equipment in Electrically Heated Dwellings, (%)

Segment	Incidence of Supplemental Non-electric Space Heating Equipment (%)		
	Lower Mainland	Vancouver Island	Interior
Single-family	70	65	76
Duplex	46	29	35
Row	39	13	27
Apartment	32	14	17
Mobile/Other	33	44	50

2.4 ANNUAL APPLIANCE ELECTRICITY USE

Exhibit 2.10 summarizes the estimated average annual “unit electricity consumption” (UEC) for major end-use appliances for the Lower Mainland region.

The values shown in Exhibit 2.10 apply to the current “stock mix” in the Lower Mainland. UECs vary slightly by service region, in some cases because of differences in occupancy rates. A brief discussion is provided below for each end-use appliance shown in Exhibit 2.10.

(Appendix A specifies UECs for the other service regions.)

Exhibit 2.10: Annual Appliance Electricity Use (UEC) for the Lower Mainland in 2001, (kWh/yr.)

Segment	Vent. kWh/yr.	DWH kWh/yr.	Cook. kWh/yr.	Refrig. kWh/yr.	Freezer kWh/yr.	Dish. kWh/yr.	Washer ^a kWh/yr.	Dryer ^a kWh/yr.	Micro. kWh/yr.	Computer kWh/yr.	Light kWh/yr.	ColorTV kWh/yr.	Other kWh/yr.
Single-family/Duplex Dwelling, Non-electric Heating	550	3403	780	945	780	101	84	1,042	182	130	1,866	513	2,150
Single-family/Duplex Dwelling, Pre 1976, Electric Heating	50	3403	780	945	780	101	84	1,042	182	130	1,866	513	2,150
Single-family/Duplex Dwelling, Post 1976, Electric Heating	50	3403	780	945	780	101	84	1,042	182	130	1,866	513	2,150
Row, Non-electric Heating	331	2,705	604.5	945	780	78.12	63.24	814	182	130	1,400	513	1,450
Row, Pre 1976, Electric Heating	41	2,705	604.5	945	780	78.12	63.24	814	182	130	1,400	513	1,450
Row, Post 1976, Electric Heating	41	2,705	604.5	945	780	78.12	63.24	814	182	130	1,400	513	1,450
Low-rise Apartment Units, Non-electric Heating	28	2,107	421	632	378	56	46	585	182	130	700	513	300
Low-rise Apartment, Non-electric Heating, Whole Building Corridor	4,000										20,000		2,900
Low-rise Apartment Units, Electric Heating	28	2,107	421	632	378	56	46	585	182	130	700	513	300
Low-rise Apartment, Electric Heating, Whole Building Corridor	4,000										19,000		2,900
High-rise Apartment Units, Non-electric Heating	28	2,107	421	632	378	56	46	585	182	130	700	513	300
High-rise Apartment, Non-electric Heating, Whole Building Corridor	22,900										145,000		37,000
High-rise Apartment Units, Electric Heating	28	2,107	421	632	378	56	46	585	182	130	700	513	300
High-rise Apartment, Electric Heating, Whole Building Corridor	22,900										156,700		37,000
Mobile Non-electric Heating	233	2,650	591	945	780	76	64	795	182	130	1,020	513	3,000
Mobile Electric Heating	38	2,650	591	945	780	76	64	795	182	130	1,020	513	3,000

^aAs detailed data were not available, electricity use for laundry appliances located in apartment common areas is included in the "other" end use. UEC's for dishwashers and clothes washer are for mechanical energy only; hot water use is included in the DWH UEC.

Occupancy

Occupancy rates²¹ for each dwelling type were developed from BC Hydro's REUS data. They are used, as applicable, to estimate electricity use for occupant-sensitive end uses, such as domestic hot water (DHW), laundry and lighting. Exhibit 2.11 summarizes the occupancy rates.

Exhibit 2.11: Occupancy Rates by Detachment

Detachment	Number of Occupants		
	Lower Mainland	Vancouver Island	Interior
Single-family	3.14	2.7	2.59
Duplex	2.74	2.53	2.44
Row	2.55	2.33	2.1
Apartment	1.75	1.68	1.54
Mobile/Other	2.38	2.44	2.05

Ventilation

Ventilation electricity is associated with fan/blower electricity in heating systems, kitchen fans, bathroom fans and heat recovery ventilators. A furnace fan UEC of 500 kWh (heat mode only) is assumed for single-family dwellings. This value is in the lower range of Canadian end-use metered data, as reported in a recent study²² conducted for Natural Resources Canada. A lower range value was selected in recognition of the relatively lower space heating load found in most of the regions of B.C. The value is also consistent with electricity consumption outputs from the thermal simulation model (HOT-2000).

For the purpose of estimating kitchen and bathroom fan electricity, it was assumed that a typical exhaust fan is rated at 75 watts, that all bathrooms and kitchens have fans and they operate, on average, for two hours per day.

Domestic Hot Water

UEC estimates for DHW assume a per capita hot water consumption of 45 litres per person per day, a temperature rise of 45°C and the occupancy rates shown in Exhibit 2.12. Based on the preceding assumptions, the resulting DHW estimate provides a good match with BC Hydro's billing data. Exhibit 2.12 shows the distribution of DHW load by major end use.

Exhibit 2.12: Distribution of DHW Electricity Use by End Use in Existing Stock, (kWh/yr.)

End Use	Electricity Use (kWh/yr.)	%
Personal Use	1,190	35
Dishwashing	784	23
Clothes Washing	928	27
Standby Losses	500	15
Total	3,403*	100

* Differs due to rounding.

²¹ Electricity use related to personal consumption increases with number of occupants in dwelling.

²² This area is the focus of extensive research efforts. See: Gusdorf, John, *Final Report on the Project to Measure the Effects of ECM Furnace Motors on Gas Use at the CCHT Research Facility*, Natural Resources Canada, January 2003. Current estimates of fan energy use vary widely; upper range estimates (heat mode only) exceed 1,000 kWh/yr. Continuous ventilation or use with space cooling equipment would increase fan motor consumption.

To assess further the validity of the DHW consumption values shown in Exhibit 2.12, a review of estimated DHW consumption trends was completed for the major DHW end uses. In addition to the increased stock penetration of low-flow showerheads and faucets, the review found that there has been a 36% decrease in hot water use in clothes washers and a 41% decrease in hot water use in dishwashers (NRCan 2001). Consequently, it is felt that the DHW values shown in Exhibit 2.10 are consistent with the best available data in other jurisdictions.

Cooking, Refrigerator, Freezer and Dishwasher

UEC estimates for existing stock of this group of food preparation and storage appliances were obtained from *The End Use Energy Data Handbook* (NRCan, 2002). Electricity consumption was adjusted for occupancy rates. The values shown for dishwashers are for mechanical electricity only; hot water use is included with the DHW UEC.

Clothes Washer and Dryer

Appliance UEC data was obtained from *The End Use Energy Data Handbook* (NRCan, 2002) and adjusted for occupancy rates. The values shown for clothes washers are for mechanical electricity only; hot water use is included with the DHW UEC.

Microwave oven

Appliance UEC data were obtained from *The End Use Energy Data Handbook* (NRCan, 2002) and adjusted for occupancy rates.

Computers

UEC estimates for computers were obtained from published sources (Lawrence Berkley Laboratory, LBL, 1997) and confirmed with BC Hydro calculations.²³

Lighting

The lighting loads shown in Exhibit 2.10 were developed from several sources, including:

- BC Hydro's *Residential End-Use Survey* data on lighting types and usage patterns for each dwelling type;
- *Energy Data Source Book for the U.S. Residential Economy* (LBL, 1997);
- estimates contained in the current BC Hydro Residential Electricity End-use Planning (REEP) model; and
- *The End Use Energy Data Handbook* (NRCan, 2002).

Exhibit 2.13 shows the derivation of the lighting UECs shown in Exhibit 2.11.

²³ Personal communication: Gary Hamer.

Exhibit 2.13: Derivation of Lighting UECs

Lighting	Lower Mainland		Vancouver Island		Interior	
Incandescent						
Number of regularly used bulbs						
SFD/Duplex	18		15		15	
Row	14		13		13	
Apt	7		7		7	
Mobile/Other	10		9		9	
Average wattage	60		60		60	
Average Hours/year	1,200		1,200		1,200	
Fluorescent						
Number of regularly used lamps/CFLs	<u>Lamp</u>	<u>CFL</u>	<u>Lamp</u>	<u>CFL</u>	<u>Lamp</u>	<u>CFL</u>
SFD/Duplex	6	1.00	5	1.00	5	1.00
Row	4	0.75	3	0.75	3	0.75
Apt	2	0.50	1	0.50	1	0.50
Mobile/Other	2	0.50	2	0.50	2	0.50
Average wattage (including ballast)	48	15	48	15	48	15
Average Hours/year	1,200	1,200	1,200	1,200	1,200	1,200
Holiday/Other Exterior Lighting						
Average wattage						
SFD/Duplex	400		325		325	
Row	325		250		250	
Apt	200		164		164	
Mobile/Other	300		225		225	
Average Hours/year	450		450		450	
Total Base Year Energy Use (kWh/yr)						
SFD/Duplex	1,866		1,530		1,530	
Row	1,400		1,222		1,222	
Apt	700		622		622	
Mobile/Other	1,020		877		877	

Note: SFD = Single-family Detached. Fluorescent lamp refers to "typical" 4-ft tubes; CFL refers to compact fluorescent lamps.

Colour Television

Appliance UECs were obtained from Lawrence Berkley Laboratory (LBL, 1997) data.

Other

"Other" end uses include a wide range of appliances found in most homes. Exhibit 2.14 summarizes typical appliances and their associated annual electricity consumption. In the current analysis, this end use represents a significant proportion of total electricity consumption.

Exhibit 2.14: Typical UECs for "Other" Appliances, (kWh/yr.)

Appliance	UEC	Appliance	UEC
Waterbed heater	900	Cable box	175
Automatic drip coffeemaker	116	Video cassette recorder	57
Air conditioner	n/a	Rack audio system	55
Iron	53	Doorbell	44
Spa/Hot tub*	2,300	Copier	25
Electric blanket	120	Clock	26
Toaster	39	Answering machine	35
Hair dryer	35	Clock radio	18
Toaster oven	50	Cordless phone	26
Percolator coffeemaker	65	Video game	24
Slow cooker	16	Boom box	19
Waffle iron	25	Laser printer	249
Hot plate	30	Garage door opener	44
Auto block heater	250	Security system	43
Deep fryer	20	Ink jet fax	216
Heat tape	100	Printers	45
Hair setter	10	Satellite dish	96
Heating pad	3	Home medical equipment	400
Automatic griddle	5	Instant hot water	160
Espresso maker	19	Curling iron	1
Electric grill	180	Hot oil corn popper	2.5
Air corn popper	6	Compact audio	81
Electric kettle	75	Dehumidifier	n/a

* There is a wide variation in spa/hot tub UECs, ranging from 300 kWh to over 15,000 kWh/yr.

Confidence Levels

The UECs for the major end-use appliances compare quite well with the values contained in NRCan's national database of appliance energy use and with the results provided in selected residential analyses (*see* Section 10: Bibliography).

Overall, the area of least confidence remains the "Other" category. Lighting UECs are also subject to some uncertainty, but the margin of error is not expected to exceed 20%.

2.5 APPLIANCE SATURATION

Exhibit 2.15 summarizes the saturation levels assumed for the present analysis. The values shown there are for the Lower Mainland. Saturation levels vary slightly by service region, and those for other service regions are provided in Appendix A. In each case, the assumed saturation levels are developed from the most recent BC Hydro REUS. Saturations were obtained through querying the database, by end use and detachment; minor refinements were made in selected cases to assist in calibration.

Exhibit 2.15: Appliance Saturation Levels for the Lower Mainland in 2001, (%)

Segment	Vent. %	DWH %	Cook. %	Refrig. %	Freezer %	Dish. %	Washer* %	Dryer* %	Micro. %	Computer %	Light. %	ColorTV %	Other %
Single-family/Duplex Dwelling, Non-electric Heating	100%	100%	100%	126%	76%	80%	92%	88%	96%	108%	100%	203%	100%
Single-family/Duplex Dwelling, Pre 1976, Electric Heating	100%	100%	100%	126%	76%	80%	92%	88%	96%	108%	100%	203%	100%
Single-family/Duplex Dwelling, Post 1976, Electric Heating	100%	100%	100%	126%	76%	80%	92%	88%	96%	108%	100%	203%	100%
Row, Non-electric Heating	100%	100%	100%	108%	47%	78%	88%	95%	94%	91%	100%	177%	100%
Row, Pre 1976, Electric Heating	100%	100%	100%	108%	47%	78%	88%	95%	94%	91%	100%	177%	100%
Row, Post 1976, Electric Heating	100%	100%	100%	108%	47%	78%	88%	95%	94%	91%	100%	177%	100%
Low-rise Apartment Units, Non-electric Heating	100%	100%	100%	100%	10%	50%	50%	45%	91%	63%	100%	100%	100%
Low-rise Apartment, Non-electric Heating, Whole Building Corridor	100%	100%	100%	100%	10%	50%	50%	45%	91%	63%	100%	100%	100%
Low-rise Apartment Units, Electric Heating	100%	100%	100%	100%	10%	50%	50%	45%	91%	63%	100%	100%	100%
Low-rise Apartment, Electric Heating, Whole Building Corridor	100%	100%	100%	100%	10%	50%	50%	45%	91%	63%	100%	100%	100%
High-rise Apartment Units, Non-electric Heating	100%	100%	100%	100%	15%	50%	50%	45%	91%	63%	100%	127%	100%
High-rise Apartment, Non-electric Heating, Whole Building Corridor	100%	100%	100%	100%	15%	50%	50%	45%	91%	63%	100%	127%	100%
High-rise Apartment Units, Electric Heating	100%	100%	100%	100%	15%	50%	50%	45%	91%	63%	100%	127%	100%
High-rise Apartment, Electric Heating, Whole Building Corridor	100%	100%	100%	100%	15%	50%	50%	45%	91%	63%	100%	127%	100%
Mobile Non-electric Heating	100%	100%	100%	108%	48%	50%	79%	83%	97%	37%	100%	179%	100%
Mobile Electric Heating	100%	100%	100%	108%	48%	50%	79%	83%	97%	37%	100%	179%	100%

* As detailed data were not available, electricity use for laundry appliances located in apartment common areas is included in the "other" end use.

Source: BC Hydro Residential End Use Survey (REUS, July 2001).

2.6 ELECTRICITY FUEL SHARE

Exhibit 2.16 summarizes the electricity fuel shares assumed for each of the end uses included in the present analysis. As in the preceding discussions, the values shown are for the Lower Mainland. Appendix A provides values for the remaining service regions.

As noted previously, with the exception of space heating, fuel shares are taken from the most recent BC Hydro REUS. In the case of space heating, the starting point was the distribution of space heating appliances, by fuel type, as contained in the REUS and in the EnerGuide for Houses database. Both sources confirm that natural gas (67%) and electricity (27%) are the primary space heating fuels in the Lower Mainland. However, the same data also confirm that supplemental heating is widespread in dwellings heated primarily both by electricity and natural gas.

The more difficult question is the amount of heating load that is met by:

- Electricity in non-electrically heated dwellings (primarily natural gas); and
- Non-electric sources in electrically heated dwellings.

The space heating fuel shares presented in Exhibit 2.16 have been selected on the basis that they provide a reasonable "fit" with:

- General market description (i.e., known distribution of heating appliances by fuel);
- Conditional demand analysis of customer billing data; and
- Results of a database query of the consultant home energy audit database.

Exhibit 2.16: Electricity Fuel Shares for the Lower Mainland in 2001, (%)

Segment	Space heating %	Vent. %	DWH %	Cook. %	Refrig. %	Freezer %	Dish. %	Washer* %	Dryer* %	Micro. %	Computer %	Light. %	ColorTV %	Other %
Single Family/Duplex Dwelling														
Non-Electric Heating	13%	100%	11%	85%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Single Family/Duplex Dwelling - Pre 1976, Electric Heating	70%	100%	61%	85%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Single Family/Duplex Dwelling - Post 1976, Electric Heating	70%	100%	61%	85%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Row - Non-Electric Heating	11%	100%	7%	96%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Row - Pre 1976 Electric Heating	72%	100%	72%	96%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Row - Post 1976 Electric Heating	72%	100%	72%	96%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Low Rise Apartment Units	7%	100%	5%	94%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Non-Electric Heating														
Low Rise Apartment - Non-Electric Heating - Whole Building Corridor	1%	100%										100%		100%
Low Rise Apartment Units	100%**	100%	25%	94%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Electric Heating														
Low Rise Apartment - Electric Heating - Whole Building Corridor	5%	100%										100%		100%
High Rise Apartment Units	15%	100%	5%	94%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Non-Electric Heating														
High Rise Apartment - Non-Electric Heating - Whole Building Corridor	1%	100%										100%		100%
High Rise Apartment Units	100%**	100%	25%	94%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Electric Heating														
High Rise Apartment - Electric Heating - Whole Building Corridor	5%	100%										100%		100%
Mobile	40%	100%	75%	100%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Mobile														
Electric Heating	80%	100%	100%	100%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%

*As detailed data were not available, electricity use for laundry appliances located in apartment common areas is included in the "other" end use.

**It is recognized that a small share of apartment space heating is from natural gas fireplaces; however, data were not available for further analysis.

Source: BC Hydro Residential End Use Survey (REUS,) July 2001.

2.7 AVERAGE ELECTRICITY USE PER UNIT

Exhibit 2.17 combines the building stock, efficiency, saturation and fuel share data presented in the preceding exhibits and shows the resulting electricity use, by end use, for each dwelling type.

Appendix A presents average electricity use data for the remaining service regions.

Exhibit 2.17: Average Electricity Use per Dwelling Unit for the Lower Mainland in 2001, (kWh/yr.)

Segment	Space Heating kWh/yr.	Vent. kWh/yr.	DWH kWh/yr.	Cook. kWh/yr.	Refrig. kWh/yr.	Freezer kWh/yr.	Dish. kWh/yr.	Washer* kWh/yr.	Dryer* kWh/yr.	Micro. kWh/yr.	Computer kWh/yr.	Light. kWh/yr.	ColorTV kWh/yr.	Other kWh/yr.	TOTAL kWh/yr.
Single Family/Duplex Dwelling Non-Electric Heating	1,645	550	374	663	1,191	593	81	77	889	175	140	1,866	1,041	2,150	11,436
Single Family/Duplex Dwelling - Pre 1976, Electric Heating	9,256	50	2,076	663	1,191	593	81	77	889	175	140	1,866	1,041	2,150	20,248
Single Family/Duplex Dwelling - Post 1976, Electric Heating	7,459	50	2,076	663	1,191	593	81	77	889	175	140	1,866	1,041	2,150	18,451
Row - Non-Electric Heating	757	331	189	580	1,021	367	61	56	750	171	118	1,400	908	1,450	8,158
Row - Pre 1976 Electric Heating	4,079	41	1,948	580	1,021	367	61	56	750	171	118	1,400	908	1,450	12,949
Row - Post 1976 Electric Heating	3,312	41	1,948	580	1,021	367	61	56	750	171	118	1,400	908	1,450	12,182
Low Rise Apartment Units Non-Electric Heating	200	28	105	396	632	38	28	23	255	166	82	700	513	300	3,466
Low Rise Apartment - Non-Electric Heating - Whole Building Corridor	364	4,000										20,000		2,900	27,264
Low Rise Apartment Units Electric Heating	2,800	28	527	396	632	38	28	23	255	166	82	700	513	300	6,487
Low Rise Apartment - Electric Heating - Whole Building Corridor	1,818	4,000										19,000		2,900	27,718
High Rise Apartment Units Non-Electric Heating	400	28	105	396	632	57	28	23	255	166	82	700	652	300	3,823
High Rise Apartment - Non-Electric Heating - Whole Building Corridor	3,058	22,900										145,000		37,000	207,958
High Rise Apartment Units Electric Heating	2,700	28	527	396	632	57	28	23	255	166	82	700	652	300	6,545
High Rise Apartment - Electric Heating - Whole Building Corridor	10,400	22,900										156,700		37,000	227,000
Mobile Non-Electric Heating	2,800	233	1,988	591	1,021	374	38	51	640	177	48	1,020	918	3,000	12,898
Mobile Electric Heating	5,600	38	2,650	591	1,021	374	38	51	640	177	48	1,020	918	3,000	16,166

* As detailed data were not available, electricity use for laundry appliances located in apartment common areas is included in the "other" end use.

2.8 SUMMARY OF MODEL RESULTS

This section presents the results of the model runs for the base year FY 2000/01. The results are measured at the customer's point of use and do not include line losses; they are presented in four separate exhibits:

- Exhibit 2.18 presents the model results for the total BC Hydro service area. The results are broken out by building segment and end use.
- Exhibits 2.19 to 2.21, inclusive, present the same results, broken out by segment and end use for each of the three service regions defined for this CPR.

Exhibit 2.18: Electricity Consumption for the Total BC Hydro Service Area, Modelled by End Use and Segment in the Base Year (2000/01), (GWh/yr.)

Segment	Heating	Vent	DHW	Cook	Refrig.	Freezer	Dish	Washer	Dryer	Micro	Computer	Light	Colour TV	Other	Totals
SFD/Duplex	2,414	372	771	503	952	526	57	57	674	141	103	1,374	790	1,701	10,434
Row	177	23	92	58	105	42	6	6	74	18	12	139	92	144	988
Low-rise/other	277	91	82	112	184	12	8	7	72	46	23	618	156	147	1,835
High-rise	134	44	34	50	82	7	3	3	32	21	10	346	84	100	950
Mobile/other	209	21	185	51	102	31	3	5	66	18	7	93	89	253	1,134
Total	3,211	550	1,165	774	1,425	620	76	77	919	244	155	2,570	1,211	2,344	15,342

*Results are measured at the customer's point of use and do not include line losses.

Exhibit 2.19: Electricity Consumption for the Lower Mainland, Modelled by End Use and Segment in the Base Year (2000/01), (GWh/yr.)

Segment	Heating	Vent	DHW	Cook	Refrig.	Freezer	Dish	Washer	Dryer	Micro	Computer	Light	Colour TV	Other	Totals
SFD/Duplex	856	223	202	283	509	253	35	33	380	75	60	798	445	919	5,071
Row	127	18	61	46	80	29	5	4	59	13	9	110	71	114	746
Low-rise/other	167	61	40	79	126	8	6	5	51	33	16	413	102	100	1,204
High-rise	99	34	20	39	63	6	3	2	25	17	8	269	65	80	730
Mobile/other	79	5	51	15	25	9	1	1	16	4	1	25	23	74	330
Total	1,329	341	374	462	803	305	49	46	531	142	95	1,614	706	1,286	8,081

*Results are measured at the customer's point of use and do not include line losses.

Exhibit 2.20: Electricity Consumption for Vancouver Island, Modelled by End Use and Segment in the Base Year (2000/01), (GWh/yr.)*

Segment	Heating	Vent	DHW	Cook	Refrig.	Freezer	Dish	Washer	Dryer	Micro	Computer	Light	Colour TV	Other	Totals
SFD/Duplex	1,132	62	396	117	220	127	11	12	151	34	23	289	172	406	3,152
Row	38	3	23	8	18	8	1	1	10	3	2	19	14	20	167
Low-rise/other	68	18	33	19	35	3	1	1	13	9	5	126	35	31	398
High-rise	19	6	9	6	11	1	0	0	4	3	1	51	11	13	137
Mobile/other	53	4	49	11	26	16	1	2	18	4	2	21	17	72	295
Total	1,309	94	510	162	309	154	14	16	197	52	32	506	250	543	4,149

*Results are measured at the customer's point of use and do not include line losses.

Exhibit 2.21 Electricity Consumption for the Interior, Modelled by End Use and Segment in the Base Year (2000/01), (GWh/yr.)*

Segment	Heating	Vent	DHW	Cook	Refrig.	Freezer	Dish	Washer	Dryer	Micro	Computer	Light	Colour TV	Other	Totals
SFD/Duplex	426	86	174	102	223	146	11	12	142	33	20	287	172	375	2,211
Row	13	2	9	5	7	6	0	0	5	2	1	10	7	10	75
Low-rise/other	42	12	9	14	24	1	1	1	8	3	2	79	19	16	232
High-rise	15	4	4	5	8	1	0	0	3	2	1	27	8	7	83
Mobile/other	77	12	85	25	52	7	1	2	32	9	4	47	49	107	510
Total	573	115	281	151	313	161	14	16	190	49	28	450	255	515	3,111

*Results are measured at the customer's point of use and do not include line losses.

2.9 COMPARISON WITH BC HYDRO BILLING DATA

Exhibit 2.22 compares the modelled results with actual billing data for the total BC Hydro as well as for each of the service regions. As illustrated in Exhibit 2.22, there is a relatively good match between the model results and the actual billing data.

Exhibit 2.22: Comparison of Model Results with Actual BC Hydro Billing Data, (GWh/yr.)

Segment	Lower Mainland			Vancouver Island			Interior			Total		
	BCH	Model	% diff.	BCH	Model	% diff.	BCH	Model	% diff.	BCH	Model	% diff.
SFD/Duplex	5,063	5,071	0	3,150	3,152	0	2,209	2,211	0	10,422	10,434	0
Row	731	746	2	164	167	2	73	75	3	968	988	2
Low-rise	1,204	1,204	0	398	398	0	232	232	0	1,834	1,835	0
High-rise	730	730	0	137	137	0	83	83	0	950	950	0
Mobile/other	455	330	-27	261	295	13	497	510	3	1,213	1,134	-6
Subtotal	8,183	8,081	-1	4,110	4,149	1	3,094	3,111	1	15,387	15,342	0

3. REFERENCE CASE

3.1 INTRODUCTION

This section presents the Residential Reference Case for the FYs 2000/01 to 2015/16. The Reference Case estimates the expected level of electricity consumption that would occur over the study period in the absence of new Power Smart initiatives or rate changes.²⁴ The Reference Case, therefore, provides the point of comparison for the subsequent calculation of remaining economically attractive electricity savings opportunities.

The Reference Case discussion is presented within the following subsections:

- Estimation of Net Space Heating Loads—New Dwellings
- Stock Growth
- “Natural” Changes to Space Heating Loads—Existing Dwellings
- “Natural” Changes to Electric Appliance UECs
- Fuel Shares and Saturation Levels
- End-use Model Results
- Comparison with BC Hydro Forecast.

3.2 ESTIMATION OF NET SPACE HEATING LOADS—NEW DWELLINGS

The first task in building the Reference Case involved the development of thermal archetypes for the new stock. As was the case with existing stock, the archetypes were developed using HOT-2000. Two major data sources were referenced:

- The EnerGuide for Houses database; and
- The BC Building Code.

The EnerGuide database was queried for homes constructed after 1998 (those corresponding to the current version of the Building Code). The database outputs were then referenced in developing physical descriptions, such as floor area, window area and air leakage rates for new single-family, duplex, row and mobile dwellings.

Insulation levels for new single-family, duplex and row houses were obtained from the current version of the BC Building Code. Exhibit 3.1 presents a summary. Discussions with provincial government staff indicated that no major changes to the requirements for thermal insulation are anticipated over the Reference Case study period.

Exhibit 3.2 summarizes the resulting new net space heating loads. Several trends are notable:

- The amount of window area, as a percentage of the total exterior wall area, in new houses has increased by up to 30%.

²⁴ Some limited residual program influences remain from the earlier Power Smart initiatives.

- In the Lower Mainland and Interior regions, the new stock tends to have floor areas that are 10% larger, on average; these same buildings also feature a 20% increase in exterior wall surface area as the result of the more complex wall geometry used in many of the new designs. The same trend towards larger buildings was not evident in the data for the Vancouver Island Region.
- Window thermal efficiency has increased, and air leakage rates have been reduced, but relative insulation levels have not changed significantly.

The net effect of the above trends is that, while thermal efficiencies are improving, they are being partially or wholly offset by changing construction practices.

**Exhibit 3.1: Minimum Thermal Resistance of Insulation (RSI) for Residential Buildings,
(W/m² °C)**

Assembly	Thermal Resistance (RSI)* Required	
	< 4,500 C Degree Days	> 4,500 C Degree Days
Attic Spaces	7.0	7.7
Roof Joists	4.9	4.9
Frame Wall	3.5	3.85
Suspended Floors:		
• Framed	4.9	4.9
• Concrete	2.1	2.1
Foundation Walls	2.1	2.1
Unheated Slabs	1.8	2.1

* RSI x 5.68 = R-Value

Note: In areas of 3,500 celsius degree days and where the building is heated by natural gas not supplied by the Vancouver Island natural gas pipeline, the minimum insulation required for frame walls may be reduced to RSI 2.45.

Exhibit 3.2: New Residential Units—Net Space Heating Loads²⁵ by Building Segment and BC Hydro Service Region, (kWh/yr.)

Segment	Net Space Heating Load		
	Lower Mainland	Vancouver Island	Interior
Single-family/Duplex Dwelling, Non-electric Heating	12,775	10,800	13,200
Single-family/Duplex Dwelling, Electric Heating	10,700	9,600	11,800
Row, Non-electric Heating	6,534	6,038	7,400
Row, Electric Heating	6,447	6,000	7,300
Low-rise Apartment Units, Non-electric Heating	2,750	2,650	2,900
Low-rise Apartment, Non-electric Heating, Whole Building Corridor	36,360	36,500	23,600
Low-rise Apartment Units, Electric Heating	2,750	2,650	2,800
Low-rise Apartment, Electric Heating, Whole Building Corridor	36,360	27,000	23,600
High-rise Apartment Units, Non-electric Heating	2,800	2,600	2,500
High-rise Apartment, Non-electric Heating, Whole Building Corridor	208,000	169,400	133,600
High-rise Apartment Units, Electric Heating	2,800	2,600	2,600
High-rise Apartment, Electric Heating, Whole Building Corridor	208,000	80,780	165,400
Mobile, Non-electric Heating	5,600	5,600	6,632
Mobile, Electric Heating	5,600	5,600	6,632

²⁵ Net space heating load is the space heating load of a building that must be met by the space heating system over a full year. This is equal to the total heat loss through the building envelope minus solar and internal gains. Values shown for non-electrically heating dwellings are shown in kilowatt hours for format consistency.

3.3 STOCK GROWTH

The next step in developing the Reference Case involved the development and application of estimated levels of growth in each building segment and service region over the study period. The stock growth rates employed were derived from data provided by BC Hydro.²⁶

Exhibit 3.3 presents a summary of the rates employed. Exhibit 3.4 presents the resulting number of units, by year and dwelling type.

In addition to new construction activity, there is demolition of older buildings within the stock. A review of demolition statistics from the Greater Vancouver Regional District (GVRD, 2001) and Statistics Canada (Statistics Canada, 2002) reveal that in the Lower Mainland, the demolition rate for single-family dwellings has remained relatively constant over the last 10 years at an annual rate of 0.5%. It has been close to 0% for other detachment styles. Based on data from Statistics Canada (Statistics Canada, 2002), the demolition rate for all detachments for the Vancouver Island and Interior regions was found to be approximately 0%.

Exhibit 3.3: Annual Growth Rates in Period by Building Segment and BC Hydro Service Region, (%)

Region and Period	Non-electric Accounts (%)				Electric Accounts (%)			
	Single	Row	Apt.	Mobile/ Other	Single	Row	Apt.	Mobile/ Other
Lower Mainland								
2000–2005	1.9	3.7	2.5	1.3	2.6	1.1	2.0	2.0
2005–2010	1.9	3.7	2.5	1.3	2.6	1.1	2.0	2.6
2010–2015	1.9	3.7	2.5	1.3	2.6	1.1	2.0	2.5
Vancouver Island								
2000–2005	2.0	4.3	2.0	1.4	1.8	0.7	0.3	1.6
2005–2010	2.0	4.0	2.0	1.6	2.7	1.3	1.0	2.4
2010–2015	2.0	4.0	2.0	1.5	2.5	1.6	1.0	2.3
Interior								
2000–2005	2.1	4.0	2.6	1.7	2.3	0.8	0.3	1.8
2005–2010	2.1	3.1	2.1	1.7	2.2	0.8	0.8	1.9
2010–2015	2.1	2.9	2.1	1.7	2.1	0.7	0.9	1.8

*Source: BC Hydro Load Forecast.

²⁶ Personal Communication: Larry Meyer.

Exhibit 3.4: Residential Stock, FYs 2000/01 and 2015/16, (Number of Units)

Segment	2000/01 base year			2015/16 forecast		
	Lower Mainland	Vancouver Island	Interior	Lower Mainland	Vancouver Island	Interior
Single-family/Duplex Dwelling, Non-electric Heating, Pre-2000	403,033	105,418	154,166	375,868	105,418	154,166
Single-family/Duplex Dwelling, Non-electric Heating, Post-2000	0	0	0	127,528	36,430	56,676
Single-family/Duplex Dwelling, Electric Heating, Pre-1976	6,074	17,694	11,661	5,694	17,694	11,661
Single-family/Duplex Dwelling, Electric Heating, 1976-2000	18,381	65,737	21,868	17,142	65,737	21,868
Single-family/Duplex Dwelling, Electric Heating, Post-2000	0	0	0	8,307	27,162	8,415
Row, Non-electric Heating, All Vintages	52,430	8,805	6,700	91,053	16,038	10,980
Row, Electric Heating, Pre-1976	1,585	2,349	1,435	1,585	2,349	1,435
Row, Electric Heating, 1976-2000	24,411	4,462	2,201	24,411	4,462	2,201
Row, Electric Heating, Post-2000	0	0	0	4,346	851	267
Low-rise Apartment Units, Non-electric Heating, All Vintages	153,600	35,500	29,900	222,218	47,768	41,813
Low-rise Apartment, Non-electric Heating, Whole Building Corridor, All	10,520	3,073	3,406	15,220	4,135	4,763
Low-rise Apartment Units, Electric Heating, Pre-2000	45,200	19,900	7,500	45,200	19,900	7,500
Low-rise Apartment Units, Electric Heating, Post-2000	0	0	0	15,620	2,413	806
Low-rise Apartment, Electric Heating, Whole Building Corridor, All	3,313	1,861	850	4,458	2,087	941
High-rise Apartment Units, Non-electric Heating, All Vintages	76,700	13,700	8,267	110,964	18,434	11,561
High-rise Apartment, Non-electric Heating, Whole Building Corridor, All	1,066	235	155	1,542	316	217
High-rise Apartment Units, Electric Heating, Pre-2000	23,100	3,600	3,714	23,100	3,600	3,714
High-rise Apartment Units, Electric Heating, Post-2000	0	0	0	7,983	1,295	1,134
High-rise Apartment, Electric Heating, Whole Building Corridor, All	283	123	56	381	167	73
Mobile/Other Non-electric Heating, All Vintages	20,960	17,897	48,559	25,265	22,344	62,555
Mobile/Other Electric Heating, All Vintages	3,695	6,067	5,091	5,255	8,249	6,647
Subtotal	829,169	301,129	301,062	1,111,538	400,142	403,400
Total			1,431,360			1,915,080

Note: Whole Building Corridors refers to total number of buildings.

3.4 “NATURAL” CHANGES TO SPACE HEATING LOADS—EXISTING DWELLINGS

In addition to the construction of new buildings, the Reference Case also assumes that a portion of the existing building stock is subject to energy retrofits in each period. To provide a reasonable representation of the impact of these “naturally” occurring retrofit activities on the net heating loads, it was necessary to:

- Define a bundle of upgrade measures associated with a “typical” retrofit within each building segment;
- Estimate the rate at which this bundle of measures is introduced into the existing stock of buildings; and
- Estimate the impact of these upgrades.

To estimate the naturally occurring changes to the net heating loads for existing buildings, results of the 1995 Home Energy Retrofit Survey (NRCan 2000) were reviewed in conjunction with the EnerGuide for Houses database. Exhibit 3.5 summarizes the Home Energy Retrofit Survey results.

Exhibit 3.5: Annual Retrofit Activity by Assembly and Detachment, (%)

Assembly	Single	Row	Apartment	Mobile/Other
Insulation Improvements	4.20	2.40	2.30	4.10
Exterior Doors	5.40	5.90	2.80	5.30
Window Replacements	6.70	7.00	4.10	6.60
Fireplace Improvements	2.90	1.60	1.20	2.70
Heating System Conversions	0.90	0.40	0.10	0.90
Energy Source Conversions	0.90	0.80	0.10	0.90
Equipment Replacements	2.90	2.10	1.00	2.90
Averages	3.41	2.89	1.66	3.34

Sources: 1995 Home Energy Retrofit Survey—Statistical Report (NRCan 2000) and BC EnerGuide for Houses database.

While both of the above sources provide useful references, neither source provides adequate data to allow for an accurate estimate of the overall impact. For example, the EnerGuide for Houses database only contains 20 applicable samples. Similarly, the Home Energy Retrofit Survey data show activity rates but do not link them to energy impact. Moreover, previous studies have clearly shown that a significant portion of energy retrofit activity is linked to home renovation activities, which often include the addition of new living spaces.

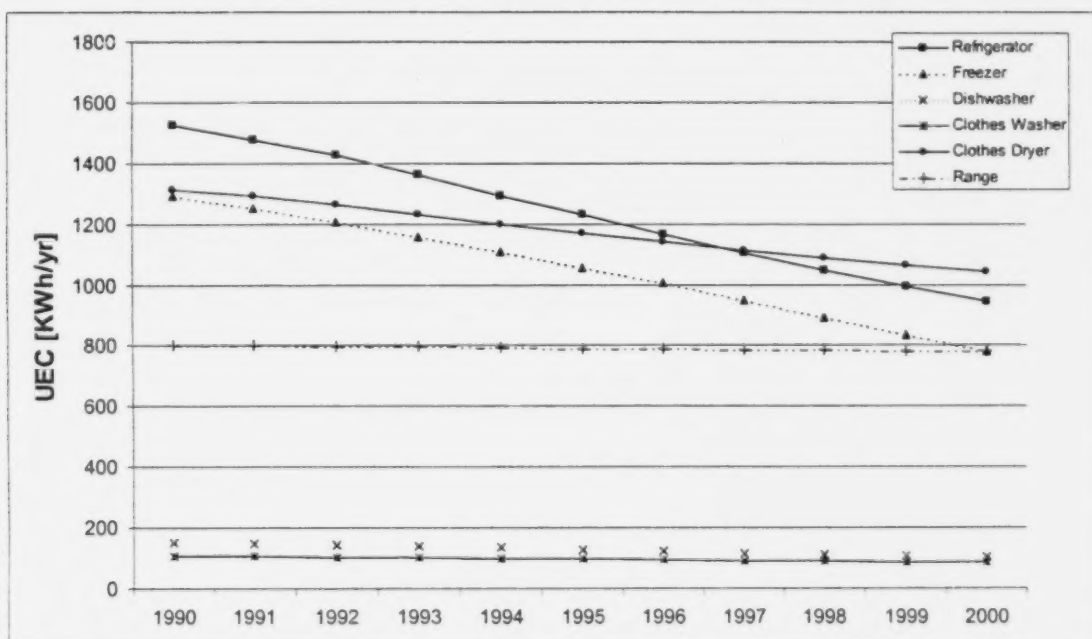
Trial energy simulation runs were undertaken in HOT-2000, assuming a variety of combinations of the above retrofit activities. As expected, the results varied widely, from about 2% to 15% reduction in heat load, depending on assumptions related to the number of windows or doors replaced, etc. In the absence of more comprehensive data, this analysis employs the insulation activity rates presented in Exhibit 3.5 and assumes that each renovated unit experiences a net space heat reduction of 3% and 2% for the pre- and post-1976 units, respectively.

3.5 “NATURAL” CHANGES TO ELECTRIC APPLIANCE UECs

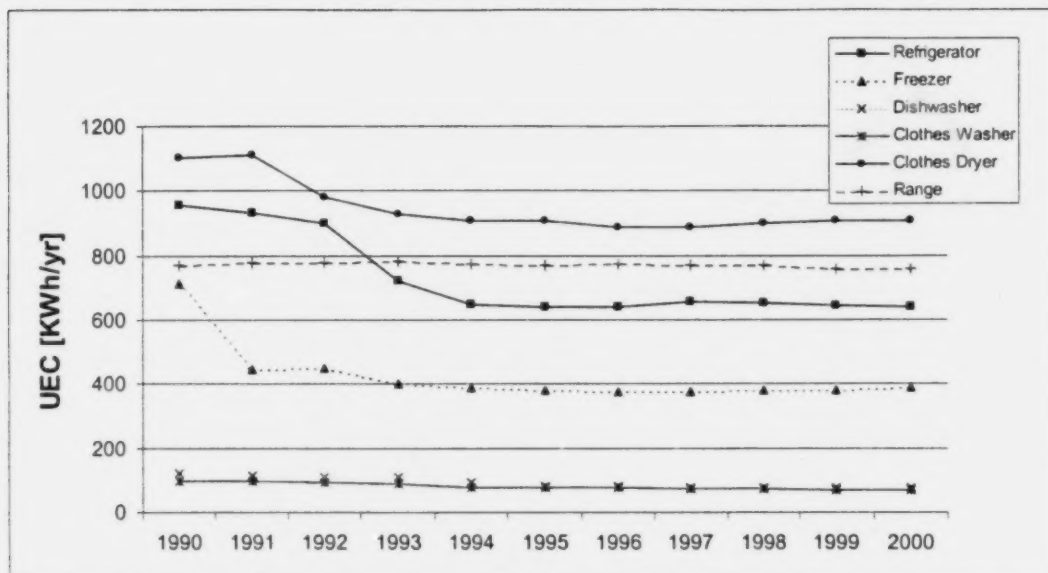
The annual unit electricity consumption (UEC) for the major household appliances has been declining steadily over the last 10 years and, in the absence of new Power Smart initiatives, it is expected that this trend will continue. In this analysis, it is important to distinguish between the UECs for new appliances and the UECs for “stock-in-place.” Improvements to the “stock-in-place” UECs tend to lag behind those for the new appliances due to the lag in turnover rates.

Exhibits 3.6 and 3.7 show Canadian trend information for both “stock-in-place” and new appliance sales for the period 1990 to 2000.

Exhibit 3.6: Canadian Major Appliance UECs, “Stock in Place”



Source: NRCan, *Energy Efficiency Trends in Canada 1990–2000*, 2002.

Exhibit 3.7: Canadian Major Appliance UECs, "Average" New Sales

Source: NRCan, *Energy Efficiency Trends in Canada 1990–2000*, 2000

As illustrated in Exhibits 3.6 and 3.7:

- There has been a steady improvement in the UECs for the stock-in-place refrigerators, freezers, washing machines, clothes dryers and dishwashers during the past 10 years. However, in the absence of new performance regulations or technical advances, current new appliance UECs, which (as shown in Exhibit 3.7) remain relatively flat, will drive future improvements to the stock UECs.
- Most of the efficiency improvements to new appliances occurred in the early to mid-1990s. Since that time, there have been few additional improvements to new appliances.
- A review of the EnerGuide Appliance Directory (NRCan, 2002) for the period 2000 to 2002 points to no further improvements, suggesting that the new appliance UEC trends shown in Exhibit 3.7 are continuing flat.
- Expected new or revised standards for energy-efficient appliances in the United States were also reviewed (U.S. DOE, 2002). Typically, new appliance standards in the United States are adopted within Canada. The only new appliance standard identified will be for clothes washers, with new regulations anticipated for the 2004 model year.

According to the available information, therefore, it has been assumed that, in the absence of new initiatives for energy efficiency, further improvements in appliance UECs will be relatively minor over the forecast period, and they will be driven primarily by the gradual stock turnover. It is therefore assumed that the UECs for the stock-in-place appliances will reach levels reflected in the current new appliance sales over the study period. Exhibit 3.8 shows the expected life of major appliances, which, for this Reference Case, is assumed to be the major determinant of rates of stock turnover.

Exhibit 3.8: Expected Life of Major Appliances, (yr.)

Appliance	Typical life (yr.)
Refrigerator	17
Freezer	21
Dishwasher	14
Clothes Washer	14
Dryer	18
Range	18

Source: Natural Resources Canada *EnerGuide Appliance Directory* 2002.

Further discussion of the modelled assumptions applied to each major appliance follows.

Domestic Hot Water

Exhibit 3.9 summarizes DHW UECs by end use for new dwellings. A comparison with the values presented previously for existing dwellings (see Section 2) shows significant reductions for hot water use in dishwashing and clothes washing; however, slightly more modest changes have been assumed for personal consumption. This may result in a modest over-estimation of personal consumption, as the 1998 B.C. Building Code has set requirements for flow rates on showerheads and faucets. However, there are also a number of uses in this category that are increasing, such as whirlpools and spas. Given that the net impact of these trends remains unknown, no reduction for personal consumption was included.

DHW electricity for new and existing appliances is obtained from Natural Resources Canada (NRCAN, 2001). For existing and retrofit buildings, the DHW UEC is assumed to decrease by 0.2% per year based on data contained in Natural Resources Canada.²⁷ The UEC for DHW in new buildings is assumed to be constant.

Exhibit 3.9: Distribution of DHW Electricity Use by End Use in New Stock, (kWh/yr.)

End Use	Electricity Use (kWh/yr.)	%
Personal Use	932	35
Dishwashing	590	23
Clothes Washing	740	27
Standby Losses	385	15
Total	2,647	100%

Ventilation

Ventilation energy in existing stock is assumed to remain constant. This assumption recognizes that there are a number of competing trends that remain unresolved at this time. On the one hand, it is recognized that there is a trend towards manufacturers' use of larger fan motors (1/2 hp versus 1/3 hp) in new furnaces to make them "air-conditioner ready". This means that furnaces replaced in the study period may have a larger furnace fan motor. However on the other hand, the trend towards larger fan motors is at least partially offset by efficiency improvements. For example, in an earlier study for the Canadian Electricity Association (CEA), Phillips noted that

²⁷ Natural Resources Canada, *Energy Efficiency Trends in Canada 1990–2000*, June 2002.

improved fan design combined with the use of permanent split capacitor fan motors had improved furnace fan efficiency by between 13% and 19%.²⁸

In new stock, average ventilation energy was assumed to increase to 656 kWh per year. This value was based on the Hot-2000 modelled results and assumes compliance with the B.C. Building Code.

Cooking

A UEC of 780 kWh/yr. is assumed in the base year, adjusted for occupancy. This value declines (straight line) to 760 kWh/yr. in the final milestone year and is based on appliance energy-use trend data compiled by Natural Resources Canada (NRCan) and reported in *Energy Efficiency Trends in Canada 1990–2000* (June 2002).

Refrigerators

A UEC of 945 kWh/yr. is assumed in the base year, adjusted for occupancy. This value declines (straight line) to 640 kWh/yr. in the final milestone year and is based on appliance energy-use trend data compiled by Natural Resources Canada (NRCan) and reported in *Energy Efficiency Trends in Canada 1990–2000* (June 2002).

Type 3 refrigerators²⁹ dominate new markets, accounting for 86% of sales, with 45% of them being in the size range 16.5 cu. ft. to 18.5 cu. ft.

Freezers

A UEC of 780 kWh/yr. is assumed in the base year, adjusted for occupancy. This value declines (straight line) to 400 kWh/yr. in the final milestone year and is based on appliance energy-use trend data compiled by Natural Resources Canada (NRCan) and reported in *Energy Efficiency Trends in Canada 1990–2000* (June 2002).

Dishwasher

A UEC of 101 kWh/yr. is assumed in the base year, adjusted for occupancy. This value declines (straight line) to 76 kWh/yr. in the final milestone year and is based on appliance energy-use trend data compiled by Natural Resources Canada (NRCan) and reported in *Energy Efficiency Trends in Canada 1990–2000* (June 2002). The values shown are for mechanical energy only; hot water use is included with the DHW UEC.

Clothes Washer

A UEC of 84 kWh/yr. is assumed in the base year, adjusted for occupancy. This value declines (straight line) to 67 kWh/yr. in the final milestone year and is based on appliance energy-use trend data compiled by Natural Resources Canada (NRCan) and reported in *Energy Efficiency Trends in Canada 1990–2000* (June 2002). The values shown are for mechanical energy only; hot water use is included with the DHW UEC.

²⁸ See: Phillips, B. *Blower Efficiency in Domestic Heating Systems*, CEA Report No. 9202-U-921, 1995 and *Optimizing Heat and Air Distribution Systems when Retrofitting Houses with Energy Efficient Equipment*, Canada Mortgage and Housing Corporation, 2002. Ventilation UECs will be higher in dwellings that have air conditioning and/or continuous ventilation; these higher values are shown in Appendix B.

²⁹ Type 3 models are defined as "refrigerator/freezer combination with automatic defrost and top-mounted freezer, without through-the-door ice service."

Clothes Dryer

A UEC of 1,042 kWh/yr. is assumed in the base year, adjusted for occupancy. This value declines (straight line) to 910 kWh/yr. in the final milestone year and is based on appliance energy-use trend data compiled by Natural Resources Canada (NRCan) and reported in *Energy Efficiency Trends in Canada 1990–2000* (June 2002).

Microwave Ovens

A UEC of 182 kWh/yr. is assumed in the base year, adjusted for occupancy. This value remains constant over the study period. While microwave ovens are becoming more efficient, their usage patterns and features (e.g., combined micro/convection ovens) are also changing. In the absence of better information as to the net impact of these changes, the UEC for microwaves was left constant.

Computer Equipment

A UEC of 130 kWh/yr. was assumed for the study period. On the one hand, flat screen monitors and laptop computers consume significantly less energy than traditional desktop models; however, these efficiency gains are being offset by the addition of new peripherals, such as scanners, and the extended operating hours that tend to accompany high-speed Internet connections. In the absence of reliable information as to the net impact of these changes, the UEC for computer equipment was left constant.

Lighting

The lighting UEC was assumed to decrease at a rate of 0.2% per year. This value is based on the results of analysis undertaken by Natural Resources Canada and reported in their *Energy End Use Data Handbook* (June 2002).

Colour Televisions

There are competing energy trends affecting this end-use. On the one, the trend towards larger screens is expected to increase consumption; however, the trend towards flat screen plasma technology will increase efficiency. Given that it is impossible to determine the outcome of these trends at this time, the UEC for colour televisions was assumed to remain constant at 513 kWh/yr.

Other

The other category was assumed to remain constant over the study period.

3.6 APPLIANCE SATURATION TRENDS

To develop estimates of the future saturation of residential equipment, references from Natural Resources Canada (NRCan, 1998) and BC Hydro and the original CPR were reviewed. A comparison of the saturation levels reported in the original CPR and the current levels reported in BC Hydro's most recent REUS show that, with two exceptions, the saturation of most end-use appliances has remained relatively constant over the last 10 years, suggesting that further changes to saturations are unlikely within the study period. The two exceptions are: computers and dishwashers. Based on the available data from Natural Resources Canada (NRCan, 1998), saturation levels for computers and dishwashers were estimated to increase by 34% and 21%, respectively.

3.7 FUEL SHARES AND SATURATION LEVELS

The current analysis assumes no fuel switching. Therefore, fuel shares are assumed to remain constant over the study period.

3.8 END-USE MODEL RESULTS

Exhibit 3.10 presents the results—broken out by dwelling type and milestone year—of the Reference Case for the total BC Hydro service area. All results are reported at the customer's point of use and do not include line losses.

Exhibit 3.10: Reference Case Model Results, (GWh/yr.)*

Segment	Lower Mainland				Vancouver Island				Interior				Total			
	2001/02	2005/06	2010/11	2015/16	2001/02	2005/06	2010/11	2015/16	2001/02	2005/06	2010/11	2015/16	2001/02	2005/06	2010/11	2015/16
SFDD/Duplex	5,071	5,282	5,544	5,888	3,152	3,348	3,644	3,972	2,211	2,349	2,508	2,703	10,434	10,979	11,695	12,563
Row	746	826	924	1,046	167	183	202	229	75	82	89	97	988	1,091	1,215	1,372
Low-rise Apt Units	1,204	1,324	1,461	1,618	398	415	441	470	232	251	269	289	1,835	1,990	2,171	2,378
High-rise Apt Units	730	806	893	992	137	148	162	177	83	91	99	107	950	1,045	1,153	1,275
Mobile/Oth	330	344	362	383	295	307	326	349	510	540	574	613	1,134	1,191	1,263	1,344
Total	8,081	8,582	9,183	9,926	4,149	4,400	4,775	5,197	3,111	3,313	3,539	3,808	15,342	16,296	17,497	18,931

*Results are measured at the customer's point of use and do not include line losses.

3.9 COMPARISON WITH BC HYDRO FORECAST

Exhibits 3.11 through 3.14 inclusive compare the model results with the BC Hydro (December 2000) Forecast. As illustrated, the modelled Reference Case matches the BC Hydro Forecast very closely.

Exhibit 3.11: Model Results versus BC Hydro Reference Case for the Total BC Hydro Service Area, (GWh/yr.)*

Segment	Base Year			2005/06			2010/11			2015/16		
	BCH	Model	%	BCH	Model	%	BCH	Model	%	BCH	Model	%
SFD/Duplex	10,422	10,434	0	11,000	10,979	0	11,829	11,695	-1	12,720	12,563	-1
Row	968	988	2	1,094	1,091	0	1,246	1,215	-2	1,418	1,372	-3
Low-rise	1,834	1,835	0	2,003	1,990	-1	2,208	2,171	-2	2,441	2,378	-3
High-rise	950	950	0	1,043	1,045	0	1,155	1,153	0	1,282	1,275	-1
Mobile/other	1,213	1,134	-6	1,269	1,191	-6	1,355	1,263	-7	1,455	1,344	-8
Subtotal	15,387	15,342	0	16,409	16,296	-1	17,793	17,497	-2	19,316	18,931	-2

*Results are measured at the customer's point of use and do not include line losses.

Exhibit 3.12: Model Results versus BC Hydro Reference Case for the Lower Mainland Region, (GWh/yr.)*

Segment	Base Year			2005/06			2010/11			2015/16		
	BCH	Model	%	BCH	Model	%	BCH	Model	%	BCH	Model	%
SFD/Duplex	5,063	5,071	0	5,287	5,282	0	5,623	5,544	-1	5,976	5,888	-1
Row	731	746	2	836	826	-1	958	924	-4	1,096	1,046	-5
Low-rise	1,204	1,204	0	1,338	1,324	-1	1,493	1,461	-2	1,667	1,618	-3
High-rise	730	730	0	811	806	-1	905	893	-1	1,011	992	-2
Mobile/other	455	330	-27	475	344	-28	506	362	-28	539	383	-29
Subtotal	8,183	8,081	-1	8,747	8,582	-2	9,485	9,183	-3	10,289	9,926	-4

*Results are measured at the customer's point of use and do not include line losses.

Exhibit 3.13: Model Results versus BC Hydro Reference Case for the Vancouver Island Region, (GWh/yr.)*

Segment	Base Year			2005/06			2010/11			2015/16		
	BCH	Model	%	BCH	Model	%	BCH	Model	%	BCH	Model	%
SFD/Duplex	3,150	3,152	0	3,337	3,348	0	3,631	3,644	0	3,957	3,972	0
Row	164	167	2	178	183	3	200	202	1	225	229	2
Low-rise	398	398	0	416	415	0	445	441	-1	481	470	-2
High-rise	137	137	0	143	148	3	153	162	6	166	177	7
Mobile/other	261	295	13	269	307	14	287	326	14	309	349	13
Subtotal	4,110	4,149	1	4,343	4,400	1	4,716	4,775	1	5,138	5,197	1

*Results are measured at the customer's point of use and do not include line losses.

Exhibit 3.14: Model Results versus BC Hydro Reference Case for the Interior Region, (GWh/yr.)*

Segment	Base Year			2005/06			2010/11			2015/16		
	BCH	Model	%	BCH	Model	%	BCH	Model	%	BCH	Model	%
SFD/Duplex	2,209	2,211	0	2,376	2,349	-1	2,575	2,508	-3	2,787	2,703	-3
Row	73	75	3	80	82	3	88	89	1	97	97	0
Low-rise	232	232	0	249	251	1	270	269	0	293	289	-1
High-rise	83	83	0	89	91	2	97	99	2	105	107	2
Mobile/other	497	510	3	525	540	3	562	574	2	607	613	1
Subtotal	3,094	3,111	1	3,319	3,313	0	3,592	3,539	-1	3,889	3,808	-2

*Results are measured at the customer's point of use and do not include line losses.

4. ENERGY EFFICIENCY UPGRADE OPTIONS

4.1 INTRODUCTION

This section identifies and assesses technical options for improving energy efficiency within the Residential Sector. The discussion is organized using the same energy end uses as in the preceding sections of this report and is presented here according to the following subsections:

- Summary of Results
- Existing Building Envelope
- Space Heating and Cooling Equipment
- New Building Design
- Ventilation
- Domestic Hot Water
- Major Appliances
- Lighting
- Plug-in Equipment.

For each end use, this section:

- Provides a brief description of the energy services provided;
- Identifies the baseline technology (or technologies) and/or practices;
- Identifies the applicable energy efficiency upgrade options;
- Provides performance and cost data for both baseline and upgrade technologies; and
- Calculates the Cost of Conserved Energy (CCE) associated with each upgrade option.

(For more detailed information *see* Appendix B, Exhibits B.1–B.26.)

4.1.1 Cost of Conserved Energy

One of the important sets of information provided in this section is the Cost of Conserved Energy (CCE)³⁰ associated with each energy efficiency upgrade option. The CCE for an energy-efficient upgrade is defined as the annualized incremental cost of the upgrade measure divided by the annual energy savings achieved, excluding any administrative or program costs required to achieve full use of the technology or measure. All cost information presented in this section and in the accompanying tables (*see* Appendix B) are constant (2002) dollars.

The CCE provides a basis for the subsequent selection of measures to be included in the Economic Potential Forecast (*see* Section 5). The CCE is calculated according to the following formula:

³⁰ The term CCE that is used in this study refers to the same methodology as was used in the original CPR. However, in the original CPR, the term Total Resource Cost (TRC) was used. In both CPRs, program and administrative costs were excluded.

$$\frac{C_A + M}{S}$$

Where:

C_A is the annualized installed cost

M is the incremental annual cost of operation and maintenance (O & M)

S is the annual kWh energy savings.

And A is the annualization factor.

$$A = \frac{i(1+i)^n}{(1+i)^n - 1}$$

Where:

i is the discount rate

n is the life of the measure.

The detailed CCE tables (*see* Appendix B) show both “incremental” and “full” installed costs for the measures or technologies, as applicable. If the measure or technology is installed in a new facility, or at the point of natural replacement in an existing facility, then the “incremental” cost of the efficient measure versus the cost of the baseline technology is used.

If, prior to the end of its life, an operating piece of equipment is replaced with a more efficient model, then the “full” cost of the efficient measure is used. In both cases, the costs of the measures are annualized, based on the number of years of equipment life and the discount rate, and the costs incorporate applicable changes in annual O & M costs.

The annual saving associated with the efficiency measure is the difference in annual electricity consumption with and without the measure. The CCE tables in Appendix B show two savings: “Energy Saving 1” and “Energy Saving 2”. Energy Saving 1 is the annual electricity savings that occur at the customer’s meter. Energy Savings 2 takes into account BC Hydro system losses and is the value used to calculate the CCEs. For distribution customers, the system losses used in this analysis are 7% (3% area transmission and 4% distribution).³¹

4.1.2 Discount Rate

The CCE calculation is sensitive to the chosen discount rate. In the CCE calculations, three discount rates are shown: 6%, 8% and 10%. Based on the recommendation of BC Hydro’s Power Planning and Acquisition Department, the 8% (net-of-inflation) discount

³¹ This approach omits bulk transmission losses of 5%; however, this is consistent with the approach being applied to other possible electricity options, such as small-scale renewable electricity. It is also consistent with the general assumption that the most likely future electricity supply options will occur at the regional levels rather than at remote sites, such as the historical large-scale hydroelectric developments.

rate was used for the primary CCE calculation. The CCEs were also calculated using the 6% and 10% discount rates to provide the sensitivity analysis.

Selection of the appropriate discount rate for this analysis was guided by the intended use of the study results. The CPR seeks to identify the economic potential for DSM in B.C. from a provincial perspective. Therefore, the appropriate discount rate is the social opportunity cost of capital, which is the estimated average pre-tax rate of return on public and private investments in the provincial economy. The intent of this discount rate is to "level the playing field" between the public entity, BC Hydro's investment in new resources, and private investment in resources (DSM and power projects). In 1989, the provincial government directed that: "BC Hydro should use an 8% discount rate for long-term planning purposes with sensitivity ranges as appropriate."³²

4.2 SUMMARY OF RESULTS

Exhibit 4.1 summarizes the calculated CCEs. The exhibit, which is organized by major end use, shows:

▪ End Uses and the Technology Upgrade Options for Each

For each end-use addressed in this study, Exhibit 4.1 shows the options for providing the same level of energy service (e.g., light) but with greater efficiency. The upgrades are organized in increasing order of savings.

▪ Detachment

This indicates to which type of dwelling the upgrade options apply.

▪ Co-Benefits

Many of the upgrade options provide occupant benefits that are additional to energy savings. The CCEs provided in Exhibit 4.1 do not place any monetary value on these additional benefits; however, it is important to note their existence, as it is expected that they positively influence the participation rates that are presented later in Section 6, Achievable Potential.

▪ Vintage

For practical purposes, measures can apply to new buildings, existing buildings or both. This information indicates the vintage of buildings to which the measure applies.

▪ Space Heating/DHW Fuel

This identifies whether the upgrade option applies only to dwellings with electric space and water heating or to all dwellings, regardless of fuel type.

³²Arguably, the 8% social opportunity of capital, estimated in 1989, may be a different value today. However, in the absence of a comprehensive review, the 8% was recommended for this CPR to reinforce the understanding that the discount rate is the social opportunity cost of capital.

▪ **Cost of Conserved Energy**

The CCEs³³ are presented for three discount rates, as applicable, on a “full cost” and/or “incremental” installation basis.

As illustrated in Exhibit 4.1, a wide range of energy-efficient upgrade options provides opportunities for energy savings for each of the major residential energy end uses. The following subsections in this chapter present further detail.

³³ Technology costs typically decline as they gain greater market share, which results in a lower CCE. Where applicable, these mature technology costs have been estimated and have been identified in the technology cost information provided.

Exhibit 4.1: Summary of Residential Technology Costs of Conserved Energy, (¢/kWh)

End Use		Technology	Detachment	Co benefits	Vintage	Sp heating fuel	CCEs (¢/kWh)					
							6.0% DR		8.0% DR		10.0% DR	
							Full	Incr.	Full	Incr.	Full	Incr.
Lighting	Upgrade 1	Replace incandescent with CFL	All Detachments		New & Exist.	Elec. & Non-elec.	1.6	1.5	1.8	1.7	2.1	1.9
	Upgrade 2	Replace incandescent with white LED	All Detachments		New & Exist.	Elec. & Non-elec.	19.0	18.7	21.3	21.0	23.7	23.4
	Upgrade 1	Replace T12 with T8	SFD/Duplex/Row/Mobile		New & Exist.	Elec. & Non-elec.	20.9		24.5		28.2	
	Upgrade 1	Replace T12 with T8	Apartment		New & Exist.	Elec. & Non-elec.	4.7		5.5		6.3	
	Upgrade 1	Exterior and holiday lights	All Detachments		New & Exist.	Elec. & Non-elec.	6.2	-2.2	7.3	-1.6	8.4	-0.9
Building Envelope	Upgrade 1	Vacuum insulation panels	All Detachments		New	Elec		33.2		37.7		42.4
	Upgrade1	High-performance glazings	SFD/Duplex	comfort, less noise mould, mildew abatement, improved resale value, aesthetics	New & Exist.	Elec		4.3		5.1		6.0
	Upgrade1	High-performance glazings	Row	comfort, less noise mould, mildew abatement, improved resale value, aesthetics	New & Exist.	Elec		4.9		5.9		6.9
	Upgrade 1	Crawl space insulation	SFD/Duplex/Row/Mobile	Comfort, mould	existing			0.4		0.5		0.6
	Upgrade 1	Air leakage sealing	SFD/Duplex/Row/Mobile	comfort, less noise, reduced drafts	New & Exist.	Elec	4.6	4.6	5.5	5.5	6.4	6.4
	Upgrade1	High-performance glazings	Apartment	comfort, less noise mould, mildew abatement, improved resale value, aesthetics	New	Elec		10.1		12.1		14.2
Heating/Cooling	Upgrade 1	Temperature setback	SFD/Duplex		New & Exist.	Elec	1.8	1.1	2.1	1.3	2.5	1.4
	Upgrade 1	Temperature setback	Row		New & Exist.	Elec	3.1	1.8	3.7	2.1	4.2	2.5
	Upgrade 1	Temperature setback	Apartment		New & Exist.	Elec	4.4	2.5	5.1	3.0	5.9	3.4
	Upgrade 1	Temperature setback	Mobile		New & Exist.	Elec	3.3	1.9	3.8	2.2	4.4	2.6
	Upgrade 1	Air source heat pump	SFD/Duplex/Row/Mobile		Existing	Elec	10.4		11.8		13.2	
	Upgrade 2	Cold-climate heat pump	SFD/Duplex/Row/Mobile		Existing	Elec	6.5		7.3		8.3	
	Upgrade 3	Ground source heat pump	SFD/Duplex/Row/Mobile		Existing	Elec	28.0		31.8		35.8	
	Upgrade 1	Air source heat pump	SFD/Duplex/Row/Mobile		New	Elec		6.4		7.2		8.2
	Upgrade 2	Cold-climate heat pump	SFD/Duplex/Row/Mobile		New	Elec		5.2		5.9		6.6
	Upgrade 3	Ground source heat pump	SFD/Duplex/Row/Mobile		New	Elec		29.6		33.6		37.8
	Upgrade 1	Air source heat pump with A/C	SFD/Duplex/Row/Mobile	provide A/C at no extra capital cost, improved comfort and value	Existing	Elec	5.7		6.5		7.3	
	Upgrade 2	Cold-climate heat pumps with A/C	SFD/Duplex/Row/Mobile	provide A/C at no extra capital cost, improved comfort and value	Existing	Elec	3.8		4.4		4.9	
	Upgrade 3	Ground source heat pump with A/C	SFD/Duplex/Row/Mobile	provide A/C at no extra capital cost, improved comfort and value	Existing	Elec	21.2		24.0		27.0	
	Upgrade 1	Air source heat pump with A/C	SFD/Duplex/Row/Mobile	provide A/C at no extra capital cost, improved comfort and value	New	Elec		3.1		3.5		3.9
	Upgrade 2	Cold-climate heat pumps with A/C	SFD/Duplex/Row/Mobile	provide A/C at no extra capital cost, improved comfort and value	New	Elec		2.8		3.1		3.5
Upgrade 3	Ground source heat pump with A/C	SFD/Duplex/Row/Mobile	provide A/C at no extra capital cost, improved comfort and value	New	Elec		18.6		21.1		23.8	

Exhibit 4.1 continued

End Use	Technology	Detachment	Co benefits	Vintage	Sp heating fuel	CCEs (¢/kWh)					
						6.0% DR		8.0% DR		10.0% DR	
						Full	Incr.	Full	Incr.	Full	Incr.
Ventilation	Upgrade1	Electronically commutated permanent magnet motors (ECPM)	SFD/Duplex		Existing	Elec. & Non-elec.		5.1		5.9	6.8
	Upgrade1	Electronically commutated permanent magnet motors (ECPM)	Row		Existing	Elec. & Non-elec.		8.4		9.8	11.3
	Upgrade1	Electronically commutated permanent magnet motors (ECPM)	Mobile		Existing	Elec. & Non-elec.		11.9		14.0	16.1
	Upgrade1	Electronically commutated permanent magnet motors (ECPM)	SFD/Duplex		New	Elec. & Non-elec.		4.2		5.0	5.7
	Upgrade1	Electronically commutated permanent magnet motors (ECPM)	Row		New	Elec. & Non-elec.		6.0		7.0	8.1
	Upgrade1	Electronically commutated permanent magnet motors (ECPM)	Mobile		New	Elec. & Non-elec.		7.5		8.8	10.1
	Upgrade1	Electronically commutated permanent magnet motors (ECPM) to provide continuous ventilation air	SFD/Duplex	lower noise, improved ventilation	New & Exist.	Elec. & Non-elec.		0.5		0.6	0.7
Service Hot Water	Upgrade1	Efficient shower/faucet	All Detachments	Exist.	Elec DHW		0.5		0.5		0.5
	Upgrade1	DHW tank insulation	SFD/Duplex	New & Exist.	Elec DHW	4.1	4.1	4.5	4.5	4.9	4.9
	Upgrade1	DHW tank insulation	Row	New & Exist.	Elec DHW	3.1	3.1	3.3	3.3	3.7	3.7
	Upgrade1	DHW tank insulation	Mobile	New & Exist.	Elec DHW	3.8	3.8	4.1	4.1	4.5	4.5
	Upgrade2	Heat trap	SFD/Duplex	New & Exist.	Elec DHW		1.9		2.1		2.3
	Upgrade2	Heat trap	Row	New & Exist.	Elec DHW		2.4		2.6		2.9
	Upgrade2	Heat trap	Apartment	New & Exist.	Elec DHW		3.1		3.4		3.7
	Upgrade2	Heat trap	Mobile	New & Exist.	Elec DHW		2.4		2.7		2.9
	Upgrade3	Heat trap + heat pump	SFD/Duplex	New & Exist.	Elec DHW		8.8		9.7		10.5
	Upgrade3	Heat trap + heat pump	Row	New & Exist.	Elec DHW		11.1		12.1		13.3
	Upgrade3	Heat trap + heat pump	Apartment	New & Exist.	Elec DHW		14.2		15.6		17.0
	Upgrade3	Heat trap + heat pump	Mobile	New & Exist.	Elec DHW		11.3		12.4		13.5
Appliances	Upgrade1	Energy Star top-loading clothes	All Detachments	New & Exist.	Elec DHW		4.3		4.9		5.5
	Upgrade2	Horizontal axis clothes washer	All Detachments	New & Exist.	Elec DHW		11.0		12.4		13.9
	Upgrade1	New Energy Star dishwasher	All Detachments	New & Exist.	Elec DHW		0.0		0.0		0.0
	Upgrade2	Highest efficiency dishwasher	All Detachments	New & Exist.	Elec DHW		15.5		17.4		19.5
	Upgrade1	Energy Star refrigerator	SFD/Duplex/Row/Mobile	New & Exist.	Elec. & Non-elec.		3.7		4.3		4.9
	Upgrade2	Highest efficiency refrigerator	SFD/Duplex/Row/Mobile	New & Exist.	Elec. & Non-elec.		68.1		79.5		91.7
	Upgrade1	Energy Star refrigerator	Apartment	New & Exist.	Elec. & Non-elec.		0.0		0.0		0.0
	Upgrade1	High efficiency freezer	SFD/Duplex/Row/Mobile	New & Exist.	Elec. & Non-elec.		17.5		20.4		23.5
	Upgrade1	High efficiency freezer	Apartment	New & Exist.	Elec. & Non-elec.		16.5		19.2		22.2
	Upgrade1	Microwave/convection oven	All Detachments	New & Exist.	Elec. & Non-elec.		93.6		102.6		112.1
	Upgrade1	Reduced standby for computers	All Detachments	New & Exist.	Elec. & Non-elec.		0.0		0.0		0.0
	Upgrade1	LCD monitors	All Detachments	New & Exist.	Elec. & Non-elec.		87.4		92.2		97.1
Plug in Equipment	Upgrade1	Television	All Detachments	New & Exist.	Elec		0.6		0.7		0.7
	Upgrade1	Miscellaneous reduced standby	All Detachments	New & Exist.	Elec. & Non-elec.		0.0		0.0		0.0
Building Design	Upgrade1	R2000 housing	SFD/Duplex	improved indoor air	New	Elec		16.3		21.1	26.0
	Upgrade1	Integrated design to 25% below current construction	Apartment		New	Elec		0.0		0.0	0.0
	Upgrade2	Integrated design to 40% below current construction	Apartment		New	Elec		4.8		6.0	7.3

4.3 EXISTING BUILDING ENVELOPE

“Building envelope” measures improve the thermal performance of the building’s walls, roof and/or windows. As illustrated in Exhibit 4.1, these measures also provide significant co-benefits, such as increased occupant comfort, improved resale value, etc.

4.3.1 Energy Efficiency Upgrade Options

Three energy efficiency upgrade options were identified and assessed for this end use. They are:

- High-performance Windows
- Crawl Space Insulation
- Air Leakage Sealing.

Each option is discussed below, with a brief description of the technology, savings relative to the baseline, typical installed costs, applicability and co-benefits. Detailed cost and performance data are provided in Appendix B.

□ High-Performance Windows

High-performance windows are double glazed with a ½-inch air space; they incorporate a number of additional energy-saving features including low E (soft coating), insulating spacers and vinyl frames (a mix of hinged and picture). Annual energy savings relative to the baseline window (double vinyl) are approximately 15%. The incremental cost for the additional energy-saving features is approximately 9%, or about \$850 in a single-family or duplex dwelling.

High-performance windows also provide occupant co-benefits, such as reduced interior noise, reduced air leakage, greater thermal comfort and fewer condensation problems.

□ Crawl Space Insulation

More than 50% of B.C.’s single-family houses incorporate a crawl space as part of the basement design and, in many cases, insulation levels remain below code. The addition of crawl space insulation in existing houses to bring the thermal resistance values up to existing code levels of R 12 (RSI 2.1) provides annual energy savings of approximately 13 kWh/yr./m².³⁴ Typical installed costs are \$7/m².

Co-benefits of improved crawl space insulation include improved thermal comfort, fewer drafts and less condensation.

³⁴ In some cases, it is possible to place insulation in the floor substructure to improve R values to 30 (RSI 4.8).

□ Air Leakage Sealing

Air sealing of building envelopes includes completion of a blower door test to quantify leakage levels and to identify the location of air leaks. Generally, major leakage occurs at window-to-wall interfaces, around doors, through electrical and plumbing penetrations and at the top of foundation walls. Installation of sealant is a generally accepted method for reducing air leakage in buildings.

In existing dwellings, air leakage can typically be reduced by as much as 40%, which results in space heating savings of 10% to 15%, or about 1,300 kWh/yr. in an existing single-family dwelling. The cost of leakage control is approximately \$900 per single-family dwelling if undertaken by an air-sealing contractor who can perform an air test as part of the work. If homeowners themselves undertake the air-sealing, significant cost savings can be achieved, but they would be unable to perform the air test.

In the analysis undertaken for this study, a minimum leakage of 0.2 air changes per hour (ACH) was maintained to ensure adequate fresh air for occupants, to avoid problems from interior moisture load and to limit combustion spillage risk. In the Interior region, no reduction in air leakage was modelled for the new stock, as natural ventilation rates are already below 0.2 ACH during winter months.

Air sealing also provides important co-benefits, including fewer drafts, and it contributes to increased occupant comfort. In addition, reduced air leakage around windows and penetrations eliminates one of the key contributors to water ingress in exterior wall assemblies.

4.4 SPACE HEATING AND COOLING EQUIPMENT

“Space heating and cooling” refers to the equipment and controls used to heat and/or cool residential dwellings. Some of the available space heating upgrade measures also provide space cooling, an important co-benefit that has not been included in the calculation of the CCE shown in Exhibit 4.1.

4.4.1 Energy Efficiency Upgrade Options

Four energy efficiency upgrade options were identified and assessed for this end use. They are:

- Temperature Setback
- Air Source Heat Pumps
- Cold Climate Heat Pumps
- Ground Source Heat Pumps.

Each option is discussed below with a brief description of the technology, savings relative to the baseline, typical installed costs, applicability and co-benefits. (For detailed cost and performance data *see* Appendix B.)

□ Temperature Setback

New programmable thermostats provide improved temperature setting accuracy and are capable of multiple time settings. When combined with an assumed 4°C temperature setback during night and unoccupied periods, typical space heat savings are in the range of 10% to 15% relative to the baseline, depending on the dwelling's vintage and type of detachment.

These thermostats can be installed in both new and existing dwellings. Most electrically heated dwellings have multiple thermostats to control individual rooms or living areas. Detached homes were assumed to have an average of 4 thermostats whereas apartments were assumed to have an average of 2.5 per suite. The typical incremental installed cost for a programmable versus non-programmable thermostat is about \$70 per thermostat.

□ Air Source Heat Pumps

Air source heat pumps are still relatively uncommon in B.C. due to the generally low summer cooling load found in most parts of the province. However, air source heat pumps can provide increased efficiency compared to the more common electric baseboard heaters. A seasonal co-efficient of performance (COP) of 1.5 is typical for air source heat pumps in most B.C. applications. The increased performance efficiency of air source heat pumps provides space-heating savings in the range of 30% relative to baseboard heaters.

Typical installed costs in new dwellings are approximately \$2,400 more than the cost of an equivalent forced air electric furnace.³⁵ The installed cost in an existing dwelling is approximately \$5,000 including new ductwork.

Air source heat pumps can also provide space cooling³⁶ in summer months at no incremental capital cost.

□ Cold Climate Heat Pumps

Cold climate heat pumps are air source heat pumps that have been optimized for colder climates. The performance of these heat pumps is expected to approach that of the ground source heat pumps but without the added cost of installing the ground loop. Currently, advanced cold climate heat pumps provide a COP of 2.4 at -12°C and a seasonal COP in the range of 2.5. Annual space heating savings relative to the typical electric baseboard heaters are in the range of 55% to 60%.

Typical installed costs in new dwellings are approximately \$3,400 more than the cost of an equivalent forced air electric furnace and approximately \$4,000 more than electric baseboard heating. Typical installed costs are approximately \$6,000 in existing dwellings, where new ductwork is required.

³⁵ Costs were not compared to forced-air natural gas furnaces as "fuel switching" options are excluded from the scope of this study.

³⁶ Summer cooling would increase BC Hydro's summer loads.

Cold climate heat pumps can also provide space cooling in summer months at no incremental capital cost.

❑ **Ground Source Heat Pumps**

Ground source heat pumps utilize ground or ground water as a source of heat and provide a COP of 2.7. Although they offer further savings relative to other heat pump types, they are expensive and cannot be used in many urban applications. Space heating savings are in the range of 65% relative to baseboard heaters. However, installed costs are approximately \$25,000 in a typical new dwelling.

These heat pumps can also provide space cooling in summer months at no incremental capital cost.

4.5 NEW BUILDING DESIGN

“New building design” integrates advances in both building envelope and space/water conditioning technologies.

4.5.1 Energy Efficiency Upgrade Options

Three energy efficiency upgrade options were identified and assessed for this end use as follows:

- R2000 for New Single-Family and Duplex Dwellings
- Integrated Design Approach (IDA) for New High-rise Apartments (25% reduction)
- Integrated Design Approach (IDA) for New High-rise Apartments (40% reduction).

Each option is discussed below with a brief description of the technology, savings relative to the baseline, typical installed costs, applicability and co-benefits. (For detailed cost and performance data *see* Appendix B.)

❑ **R2000 for New Single-Family and Duplex Dwellings**

R2000 homes are required to achieve a stringent energy budget that is determined by a combination of factors related to heating fuel, house size and climatic data. In addition, R2000 homes are required to achieve an airtightness level of 1.5 ACH at 50 Pa. Annual space heating savings are in the range of 20% to 30% relative to standard, non-electrically heated new houses. Savings in electrically heated houses are lower than those for non-electrically heated houses, as the baseline thermal requirements are more stringent for electrically heated dwellings.

Typical incremental construction costs for an R2000 home currently range from about \$6,000 to \$10,000.

A number of co-benefits are associated with R2000 construction. These include improved occupant comfort, improved air quality due to the mandatory use of heat recovery ventilators, higher re-sale value and reduced environmental impact.

❑ **Integrated Design Approach for High-rise Apartments (25% reduction)**

IDA involves systematically reducing the energy load in buildings and then ensuring that equipment is sized correctly and only operates when needed. The federal government's Commercial Building Incentive Program (CBIP) promotes this integrated design approach. Under the CBIP, the whole-building energy consumption must be at least 25% less than if the same building were constructed to current standards. Experience to date has shown not only that the energy target can be met in new buildings but, in most cases, this can be achieved at no incremental cost because the higher cost of more-efficient building design and equipment is offset by the lower cost of smaller heating, ventilation and air-conditioning (HVAC) equipment.

❑ **Integrated Design Approach for High-rise Apartments (40% reduction)**

The same IDA was also applied to new high-rise apartments with the target of a 40% reduction in whole-building energy use. This level of energy performance is comparable to that required under the Leadership in Energy and Environmental Design (LEED) program. To achieve energy savings at this level, incremental costs are estimated to be approximately \$30 to \$34/m².

4.6 VENTILATION

"Ventilation" consists of furnace blowers and kitchen/bathroom exhaust fans.

4.6.1 Energy Efficiency Upgrade Options

One energy efficiency upgrade option was identified and assessed for this end use.

- Replace Standard Furnace Fan Motor with Electronically Commutated Permanent Magnet (ECPM) Motor

The option is discussed below with a brief description of the technology, savings relative to the baseline, typical installed costs, applicability and co-benefits. (For detailed cost and performance data *see* Appendix B.)

❑ **ECPM Furnace Fan Motor**

Furnace fan motors are typically designed with permanent split capacitors (PSC), and they achieve efficiencies in the range of 30% to 50%. In contrast, ECPM motors have operating efficiencies in the range of 70%. Furnace fan motors are primarily used in central, forced air, non-electrically heated houses. When operated exclusively in space

heating mode, ECPM motors reduce fan motor electricity use³⁷ by approximately 40%. However, when the furnace fans are also operated in ventilation mode, the resulting longer hours of operation can reduce fan motor electricity use by up to 90%.

Typical installed costs are approximately \$140 more than for a standard fan motor. ECPM motors also reduce fan noise.

4.7 DOMESTIC HOT WATER

“Domestic hot water” refers to the heated water used for showers and baths, hand washing or clothes and dishwashing.

4.7.1 Energy Efficiency Upgrade Options

Four energy efficiency upgrade options were identified and assessed for this end use as follows:

- Low-flow Showers and Faucet
- Added Hot Water Tank Insulation
- Heat Trap
- Heat Trap plus Heat Pump Water Heater.

Each option is discussed below with a brief description of the technology, savings relative to the baseline, typical installed costs, applicability and co-benefits. (For detailed cost and performance data see Appendix B.)

□ Low-flow Showers and Faucets

Low-flow showers and faucets have aerators and flow restrictors to reduce water use. Typical reductions in hot water usage are in the range of 30% relative to traditional models. Installed costs are approximately \$21 for a single-family dwelling.

Low-flow water fixtures apply only to the retrofit of existing dwellings, as low-flow fixtures are required under the 1998 B.C. Building Code and the Vancouver Building By-Law for new dwellings.

□ Added Hot Water Tank Insulation

Higher levels of hot water tank insulation will reduce standing losses. In existing tanks, higher insulation levels can be achieved by adding an insulation blanket. The study assumes that, depending on the age of the water tank, standby losses in older existing

³⁷ As noted in earlier sections, this end-use is currently the focus of extensive research efforts. Recent end-use metering results suggest that in heating mode, ECM motor savings are fully offset by increased space heating fuel consumption. This is because waste heat generated by the fan motor is captured in the distributed hot air. Therefore, if the fan motor's waste heat is reduced due to increased efficiency, the primary heating fuel must make up the difference. If used to distribute cooled air, the increased fan motor efficiency (i.e., reduced waste heat) would reduce both motor consumption and the total cooling load. However, air-conditioning currently has a very low penetration in the B.C. residential market.

tanks can be reduced in the range of 10% to 20%. In new tanks, premium models featuring higher insulation levels can be purchased. The corresponding incremental cost in both cases is also about 20% per tank. No additional savings are assumed post 2005 for new tanks as new performance standards are expected to take effect that will require the lower standby losses.

☐ Heat Trap

Heat traps are installed on the exit side of the hot water tank to reduce thermal siphoning and related stand-by losses. In most applications, total hot water consumption is reduced by about 2%. Typical installed costs are about \$70.

☐ DHW Heat Pump

A DHW heat pump is installed upstream of the water heater tank, and it partially heats the domestic hot water. Due to the greater efficiency of the heat pump relative to the conventional heating coils, DHW heat pumps reduce water heating electricity use by approximately 45% in most typical installations. Typical installed costs are in the range of \$2,000, or about \$1,300 if installed in conjunction with a conventional tank.

4.8 MAJOR APPLIANCES

"Major appliances" include washing machines, dishwashers, refrigerators, freezers and ovens.

4.8.1 Energy Efficiency Upgrade Options

Eight energy efficiency upgrade options were identified and assessed for this end use as follows:

- Energy Star Top-loading (Vertical Axis) Clothes Washer
- Front-loading (Horizontal Axis) Clothes Washer
- Energy Star Dishwasher
- Highest-efficiency Dishwasher
- Energy Star Refrigerator
- Highest Efficiency Refrigerator
- High-efficiency (Manual Defrost) Freezer
- Microwave/Convection Oven.

Each option is discussed below with a brief description of the technology, savings relative to the baseline, typical installed costs, applicability and co-benefits. (For detailed cost and performance data *see* Appendix B.)

☐ Energy Star Top-Loading (Vertical Axis) Clothes Washer

Energy Star qualified clothes washers use 35% to 50% less hot water and 50% less mechanical energy per load than standard models. Typical incremental costs are about \$200 more than for the standard model.

□ Front-Loading (Horizontal Axis) Clothes Washer

Front-loading (horizontal axis) washing machines reduce hot water use by between 60% and 80%, which results in substantial energy savings compared to standard models. While a number of brands are available, their incremental cost is still substantially higher than vertical axis machines. Compared to the baseline vertical axis machine, the incremental cost of a horizontal axis washing machine is about \$550.

Horizontal axis clothes washer designs also result in less wear and tear on and fewer wrinkles in clothes. In addition, better water extraction means less dryer time, which results in further energy savings. Quantification of this latter benefit has not been included in the analysis.

□ Energy Star Dishwasher

Energy Star dishwashers save both by using improved technology for the primary wash cycle and by using less hot water to clean. Construction includes more effective washing action, energy-efficient motors and other advanced technology, such as sensors, that determine the length of the wash cycle and the temperature of the water necessary to clean the dishes. In addition, some advanced dishwashers can sense and adjust for the amount of soil on dishes, using only as much water as necessary.

Energy Star dishwashers reduce electricity consumption by approximately 24% relative to standard dishwasher models and at no incremental cost.

□ Highest Efficiency Dishwasher

The highest efficiency dishwashers available on the market were found to reduce electricity consumption by 45% through a reduction of hot water consumption and reduced machine electricity. Typical incremental costs are about \$500 relative to the standard models.

□ Energy Star Refrigerator

Energy Star refrigerators achieve substantial savings in electricity consumption through improved insulation and compressor efficiency, as well as better quality door seals and load sensors. Energy Star refrigerators reduce electricity consumption by about 35% compared to baseline models. The typical incremental cost for an Energy Star refrigerator is about \$100.

Energy Star refrigerators also provide the co-benefit of lower internal heat gains during the summer months.

□ Highest Efficiency Refrigerator

The highest efficiency refrigerators currently available are Sun Frost units. Features used to reduce electricity consumption include a super-insulated shell, separate refrigerator and freezer compartments driven by separate condensers and an advanced high-efficiency condenser and manual defrost. These models provide annual electricity savings of over

55% relative to standard models. However, they remain quite expensive at this time, with incremental costs of about \$3,000 relative to the baseline models.

❑ High-efficiency Freezer

The performance efficiency of freezers has increased significantly over the last 10 years through improved insulation and compressor efficiency. Electricity savings relative to the baseline models are approximately 17% with typical incremental costs of approximately \$150.

❑ Manual Defrost Freezer

Freezers without an automatic defrost cycle use approximately 20% less electricity than comparable freezers with the defrost cycle; they also cost less. Chest freezers experience only limited amount of frost build up over time and rarely require defrosting and, therefore, for the purposes of this study, the level of service provided is assumed to remain virtually unchanged.

❑ Microwave/Convection Oven

New models of stove combine conventional, microwave and convection ovens into a single appliance. Relative to a conventional oven, these designs provide electricity savings of about 20% to 25%; they also provide faster cooking times. Typical incremental costs are about \$1,400 relative to conventional models.

4.9 LIGHTING

“Lighting” improvements enhance the efficacy of lighting fixtures, while maintaining service levels.

4.9.1 Energy Efficiency Upgrade Options

Four energy efficiency upgrade options were identified and assessed for this end use as follows:

- Replacement of Incandescent Lamps with Compact Fluorescent Lights (CFLs)
- Replacement of Incandescent Lamps with White Light-Emitting Diode (LED) Lights
- Replacement of Existing T12 Energy Saving (ES) Fluorescent Lamps and Magnetic Ballasts with T8 Fluorescent Lamps and Electronic Ballasts
- Replacement of Incandescent Holiday Lights with LED Holiday Lights.

Each option is discussed below with a brief description of the technology, savings relative to the baseline, typical installed costs, applicability and co-benefits. (For detailed cost and performance data *see* Appendix B.)

❑ Replacement of Incandescent Lamps with Compact Fluorescent Lights

Compact Fluorescent Lights (CFLs) can be used to replace incandescent bulbs in most applications. A 15-watt CFL, which provides a light output similar to that of a 60-watt incandescent lamp, consumes 75% less electricity. Although the incremental capital cost of a CFL is about \$10 more than for a conventional incandescent lamp, the normal life of a CFL is approximately eight to ten times longer.

The reduced lighting loads also lower the cooling load, if air-conditioning is provided, but increase the heating load.

❑ Replacement of Incandescent Lamps with White Light Emitting Diode Lights

White Light Emitting Diode (LED) lights are an "emerging technology" that is expected to "mature" within the next 5 to 8 years. Annual electricity savings are estimated to be 40% to 45% relative to incandescent lamps. Incremental costs are approximately \$45 per bulb but are expected to drop as the technology matures.

The reduced lighting loads also lower the cooling load, if air-conditioning is provided, but increase the heating load.

❑ Replacement of Existing T12 Energy-saving Lamps and Magnetic Ballasts with T8 Fluorescent Lamps and Electronic Ballasts

T12 energy-saving (ES) fluorescent lamps and magnetic ballasts can be replaced with T8 fluorescent lamps and electronic ballasts. Although T8 lighting systems have achieved significant levels of market penetration in the Commercial Sector their replacement of the conventional T12 systems has been much slower in the residential markets. The T8 lighting systems provide savings of approximately 20% relative to the conventional T12 ES systems. Typical installed costs are approximately \$26 per fixture.

The reduced lighting loads also lower the cooling load, if air-conditioning is provided, but increase the heating load.

❑ Replacement of Incandescent Holiday Lights with LED Holiday Lights

LED seasonal decorative lights (including Christmas lights) can replace existing incandescent light strings. LED strings consume less than 1% of the electricity used by a comparable string of incandescent holiday lights.

LED holiday lights are just beginning to enter the market and consequently mature market prices have not yet been established. Based on the available data, it is expected that once LED lights reach market maturity, their price will be approximately \$8 more than for a conventional string of lights.

Longer life is a key product feature, as seasonal LED lights have a much longer rated life than incandescent lights.

4.10 PLUG-IN EQUIPMENT

“Plug-in Equipment” includes computer equipment, televisions and miscellaneous plug-in equipment.

4.10.1 Energy Efficiency Upgrade Options

Four energy efficiency upgrade options were identified and assessed for this end use as follows:

- Reduced Standby Losses for Computers
- LCD Computer Monitor
- Energy Star Televisions
- Reduced Standby Losses for Miscellaneous Equipment.

A brief description of each is provided below in terms the technology, savings relative to the baseline, typical installed costs, applicability and co-benefits. (For detailed cost and performance data *see* Appendix B.)

□ Reduced Standby Losses for Computers

Energy Star computers automatically power down to 15 watts or less when not in use. Electricity savings relative to the baseline computer are approximately 55% to 60%. No incremental cost is associated with this measure.

Related co-benefits of Energy Star computers include longer life and reduced waste heat, because they spend a large portion of time in a low-power sleep mode.

□ LCD Computer Monitor

Flat screen or LCD monitors use liquid crystal technology. Savings relative to the baseline computer monitors are approximately 70%. Typical incremental costs for an LCD monitor are estimated to be \$325.

□ Energy Star Colour Televisions

Energy Star televisions require 3 watts, or less, when switched off, compared to conventional equipment, which uses up to 12 watts. In terms of savings relative to the baseline, Energy Star-compliant televisions are estimated to reduce overall television electricity consumption by 19%. The incremental cost of an Energy Star television is minimal.

□ Reduced Standby Losses for Miscellaneous Equipment

Lawrence Berkeley Laboratory recently completed a study of standby losses in over 500 different types of electronic equipment. The study revealed that, on average, electronic equipment consumes 4 watts in standby mode. The same analysis revealed that products are currently available in all product classes that consume less than 1 watt in standby mode. Associated incremental costs were either negligible or very modest. Reduced standby losses apply to most household electronic and heating devices that have a sleep mode.

5. ECONOMIC POTENTIAL FORECAST

5.1 INTRODUCTION

This section presents the Residential Sector Economic Potential Forecast for the study period (FYs 2000/01 to 2015/16). The Economic Potential Forecast estimates the level of electricity consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost-effective against the long-run avoided cost of electricity in the BC Hydro service region. In this study, "cost-effective" means that the technology upgrade cost, referred to as the Cost of Conserved Energy (CCE) in the preceding section, is equal to, or less than, the avoided cost of new electricity supply delivered to the Lower Mainland (\$0.06/kWh).³⁸

The discussion in this section is organized according to the following subsections:

- Avoided Cost Used for Screening
- Major Modelling Tasks
- Technologies Included in Economic Potential Forecast
- Presentation of Results
- Interpretation of Results.

5.2 AVOIDED COST USED FOR SCREENING

BC Hydro Energy Management recommended that the Conservation Potential Review team use a "levelized" cost of \$0.06/kWh to assess which measures to promote customer efficiency (Demand-Side Management or DSM measures) are economic. When the 1991/94 Review was conducted, the avoided cost—or long-run marginal cost—was based on the cost of new large hydroelectric facilities. Today, planners expect the long-run marginal cost to be based on the cost of new, efficient, gas-fired Combined Cycle Gas Turbines (CCGT). The cost of CCGT supply per unit of electricity is significantly determined by the long-run marginal cost of natural gas. Current estimates are that the cost of new CCGT supply, is \$0.055/kWh at the Lower Mainland load centre. However, \$0.06/kWh was recommended for use in the CPR 2002 to allow a slightly more liberal screening of DSM measures for further assessment. BC Hydro does not consider the costs associated with a particular project, designed to meet specific needs, to be useful in screening categories of possible DSM measures in this Review. Using \$0.06/kWh gives BC Hydro's Power Smart program planners a more robust set of data to work with as they go through the process of bundling measures into Power Smart programs. Using \$0.06/kWh also ensures that the results of this study have a good "shelf life" for Power Smart program and resource planning purposes.

The Economic Potential Forecast incorporates all the electric energy-efficient upgrades that the technology assessment found with a CCE equal to or less than \$0.06/kWh. The BC Hydro Core team then reviewed the CCE results to ensure that no technology of consequence was being excluded by the six cents cut-off. They found no significant technologies had been excluded.

³⁸ Value provided by BC Hydro.

5.3 MAJOR MODELLING TASKS

By comparing the results of the Residential Sector Economic Potential Forecast with the Reference Case, it is possible to determine the aggregate level of potential electricity savings within the Residential Sector, as well as identify which specific building segments and end uses provide the most significant opportunities for savings.

To develop the Residential Sector Economic Potential Forecast, the following tasks were completed:

- The CCEs³⁹ for each of the energy-efficient upgrades presented in Exhibit 4.1 were reviewed, using the 8% discount rate.
- Technology upgrades that had CCEs equal to, or less than, the \$0.06/kWh threshold were selected for inclusion in the economic potential scenario, either on a “full cost” or “incremental” basis. It is assumed that technical upgrades having a “full cost” CCE that met the cost threshold were implemented in the first forecast year. It is assumed that those upgrades that only met the cost threshold on an “incremental” basis are being introduced more slowly as the existing stock reaches the end of its useful life.
- Electricity use within each of the building segments was modelled with the same energy models that were used to generate the Reference Case. However, for this forecast, the remaining “baseline” technologies included in the Reference Case forecast were replaced with the most efficient “technology upgrade option” and associated performance efficiency that met the cost threshold of \$0.06/kWh.
- When more than one upgrade option was applied to a given end use, the first measure selected was the one that reduced the electrical load. For example, measures to reduce the overall DHW load (e.g., low-flow showerheads and more efficient dishwashers) were applied before the heat pump water heater. Similarly, the cost effectiveness of the heat pump water heater was tested at the new, lower annual load and included only if it continued to meet the CCE threshold.

³⁹ The term CCE that is used in this study refers to the same methodology as was used in the original CPR. However, in the original CPR, the term Total Resource Cost (TRC) was used. In both CPRs program and administrative costs were excluded. Since the TRC normally includes program and administrative costs, it was considered clearer to use the term Cost of Conserved Energy in this effort. Adding 0.5 to 1.0 cent per kilowatt hour to the CCE used in this review would give a rough approximation of the TRC as it is usually calculated.

5.4 TECHNOLOGIES INCLUDED IN ECONOMIC POTENTIAL FORECAST

Exhibit 5.1 provides a listing of the technologies selected for inclusion in this forecast. In each case, the exhibit shows the following:

- End use affected;
- Upgrade option(s) selected;
- Dwelling types to which the upgrade options were applied; and
- Rate at which the upgrade options were introduced into the stock.

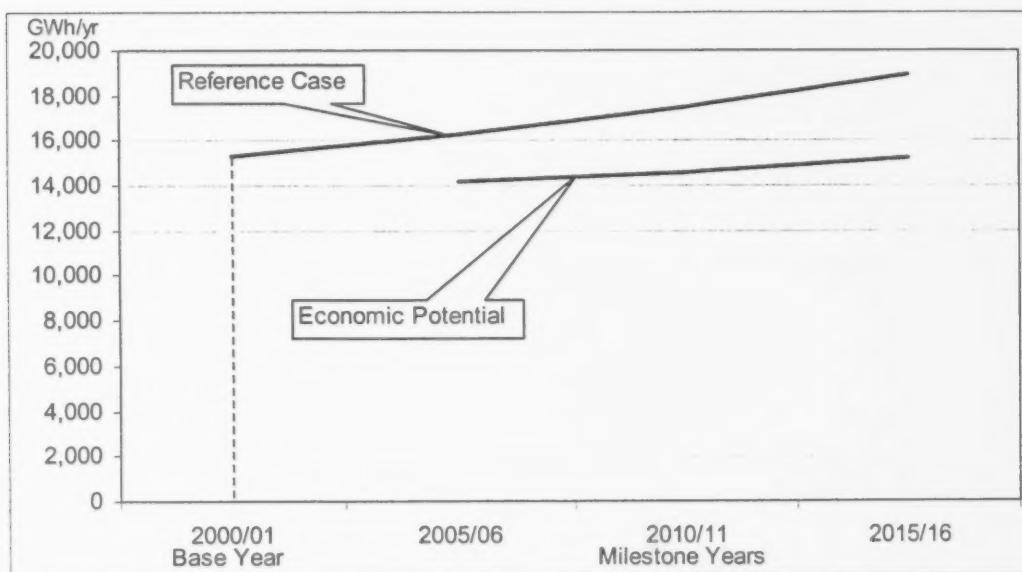
Exhibit 5.1: Technologies Included in Economic Potential Forecast

End Use	Upgrade Option	Applicability of Upgrade Options by Dwelling Type	Rate of Stock Introduction
Space Heating	High-performance glazing	- SFD/Duplex and Row - Only applied to electrically heated dwellings	- New construction, immediate - Existing, as part of envelope upgrade (below)
	Envelope package, including air-sealing and insulation	- SFD/Duplex, Row, and Mobile/Other - Only applied to electrically heated dwellings	Introduced steadily to full penetration by 2016
	Temperature setback	All	Immediate
	Advanced cold climate heat pump	SFD/Duplex only	New construction
Ventilation	ECMP motors	Single	New and replacement
DHW	Savings from new washers and dishwashers	All	See below for appliances
	Aerators and low-flow showerheads	All	- Immediate introduction 50% current penetration assumed
	Added tank insulation	SFD/Duplex, Row, and Mobile/Other	- Existing stock only - Immediate introduction to applicable stock, estimated to be 30%
Appliances	Energy Star refrigerator	All	- Existing stock, at turnover, full penetration by 2016 - New stock, immediate
	Manual defrost freezer	All	- Existing stock, at turnover, full penetration by 2016 - New stock, immediate
	Energy Star dishwasher	All	- Existing stock, at turnover, full penetration by 2016 - New stock, immediate
	Energy Star clothes washer	All	- Existing stock, at turnover, full penetration by 2016 - New stock, immediate
Computers	Energy Star computer	All	- As replaced - Full penetration by 2006
Lighting	Compact fluorescents to replace incandescents	All	- Immediate - Assumes 80% substitution
	T8 electronic lighting to replace standard fluorescent in common areas	Apartment common areas	Immediate
	Holiday lighting to LED	All	New, immediate
Colour TV	Energy Star television	All	- As replaced - Full penetration by 2016
Other	15% savings (pro-rated value based on recent LBL study)	All	Introduced steadily to 2016

5.5 PRESENTATION OF RESULTS⁴⁰

Exhibit 5.2 compares the Reference Case and Economic Potential Forecast levels of residential electricity consumption. As illustrated, under the Reference Case residential electricity use would grow from the base year level of 15,342 GWh/yr. to approximately 18,931 GWh/yr. by FY 2015/16. This contrasts with the Economic Potential Forecast in which electricity use would decline to approximately 15,206 GWh/yr. for the same period, a difference of approximately 3,725 GWh/yr.

Exhibit 5.2: Reference Case versus Economic Potential Electricity Consumption in Residential Sector, (GWh/yr.)



5.5.1 Electricity Savings

Further detail on the total potential electricity savings provided by the Economic Potential Forecast is provided in the following exhibits:

- Exhibit 5.3 presents the results by service region and milestone year;
- Exhibit 5.4 presents the results by building segment and milestone year;
- Exhibit 5.5 presents the results by end use and milestone year; and
- Exhibit 5.6 provides a further disaggregation of the savings by end use, technology, milestone year and cost.

⁴⁰ All results are reported at the customer's point of use and do not include line losses.

Exhibit 5.3: Total Potential Electricity Savings by Service Region and Milestone Year, (GWh/yr.)*

Milestone Year	Lower Mainland (GWh/yr.)	Vancouver Island (GWh/yr.)	Interior (GWh/yr.)	Total (GWh/yr.)	% Savings 2015/16 Re: Ref Case
2005/06	1,178	545	432	2,155	13
2010/11	1,548	807	596	2,951	17
2015/16	1,913	1,059	753	3,725	20
% Savings 2015/16 Re: Reference Case	19%	20%	20%	20%	

*Results are measured at the customer's point of use and do not include line losses.

Exhibit 5.4: Total Potential Electricity Savings by Building Segment and Milestone Year, (GWh/yr.)*

Dwelling Type	Milestone Year (GWh/yr.)			% Savings 2015/16	
	2005/06	2010/11	2015/16	Re: Ref Case	Re: Total
SFD/Duplex	1,424	1,988	2,531	20	68
Row	154	218	283	21	8
Low-rise	292	366	440	19	12
High-rise	154	195	238	19	6
Mobile/Other	130	184	233	17	6
Total	2,155	2,951	3,725	20	100

*Results are measured at the customer's point of use and do not include line losses.

Exhibit 5.5: Total Potential Electricity Savings by End Use and Milestone Year, (GWh/yr.)*

End Use	Milestone Year			% Savings 2015/16	
	2005/06	2010/11	2015/16	Re: Ref Case	Re: Total
Heating	113	246	377	9	10
Vent.	25	56	94	12	3
DHW	220	304	369	26	10
Cook.	0	0	0	0	0
Refrig.	178	309	399	31	11
Freezer	32	60	86	20	2
Dish.*	3	5	8	8	0
Washer*	7	16	30	36	1
Dryer	0	0	0	0	0
Micro.	0	0	0	0	0
Computer	103	122	147	53	4
Light	1,232	1,334	1,444	43	39
Colour TV	90	191	305	19	8
Other	152	308	466	15	13
Total	2,155	2,951	3,725	20	100

* Savings are for mechanical energy only; hot water savings are reported in DHW. Savings at customer's point of use.

Exhibit 5.6: Potential Electricity Savings by End Use, Technology, Segment, Milestone Year and CCE, (GWh/yr.)***

End Use	Technology	Segment	Savings (GWh/yr.)				CCE ¢/kWh **
			2005/06	2010/11	2015/16	(5)	
Heating	Temperature setback *	Apartment	(4)	(5)	(5)		3
Heating	Package of measures (setback, windows, envelope)	SFD/Duplex	60	118	170		4
Heating	Package of measures (setback, envelope)	Mobile	1	2	3		4
Heating	Package of measures (setback, windows, envelope)	Row	8	15	21		5
Heating	Cold-climate heat pump	SFD/Duplex	38	91	149		6
Heating	Integrated design to 40% below current construction	Apartment	11	24	39		6
Vent.	Electronically commutated permanent magnet motors (ECPM)	SFD/Duplex	25	56	94		6
DHW	New Energy Star dishwasher	All Detachments	19	37	51		-
DHW	Efficient shower/faucet	All Detachments	103	101	98		0
DHW	Heat trap	SFD/Duplex	5	9	14		2
DHW	Heat trap	Row	1	1	2		3
DHW	Heat trap	Mobile	1	2	3		3
DHW	DHW tank insulation	Row	3	3	3		3
DHW	Heat trap	Apartment	1	1	2		3
DHW	DHW tank insulation	Mobile	4	4	4		4
DHW	DHW tank insulation	SFD/Duplex	13	13	13		4
DHW	Energy Star top-loading clothes washer	All Detachments	71	133	178		5
Refrig.	Energy Star refrigerator	Apartment	16	31	40		-
Refrig.	Energy Star refrigerator	SFD/Duplex/Row/Mobile	162	278	360		4
Freezer	Manual defrost freezer	All Detachments	32	60	86		-
Dish.	New Energy Star dishwasher	All Detachments	3	5	8		-
Washer	Energy Star top-loading clothes washer	All Detachments	7	16	30		5
Computer	Reduced standby for computers	All Detachments	103	122	147		-
Light.	Exterior and holiday lights	All Detachments	119	127	137		(2)
Light.	Replace incandescent with CFL	All Detachments	940	1,015	1,098		2
Light.	Replace T12 with T8	Apartment	173	191	210		5
ColourTV	Television	All Detachments	90	191	305		1
Other	Various Measures	All Detachments	152	308	466		N/A
TOTAL			2,155	2,951	3,725		
All Detachments			2,155	2,951	3,725		

* Savings from temperature setback in apartments appear as a negative number as a result of the systems approach that has been used to model the energy

** ¢/kWh = cents per kilowatt hour

***Results are measured at the customer's point of use and do not include line losses.

5.6 INTERPRETATION OF RESULTS

Highlights of the results presented in the preceding exhibits are summarized below:

- **Savings by Service region**
The Vancouver Island service region offers a proportionally larger share of savings due to its higher incidence of electric space and water heating.
- **Savings by Milestone Year**
Approximately two-thirds of the economic savings can be achieved by the first milestone year; this occurs because many of the efficiency upgrades are economically attractive at full replacement cost.
- **Savings by Segment**
Single-family dwellings and duplexes account for over two-thirds of the potential savings; this reflects their larger market share and their generally higher level of electrical intensity per dwelling. Conversely, apartments offer slightly less savings potential on a percentage basis than the other segments.
- **Savings by End Use**
Lighting accounts for approximately 39% of the total electricity savings in the Economic Potential Forecast. The replacement of incandescent lamps with CFLs accounts for 75% of these potential savings, followed by conversion of T12 fluorescent lighting to T8 systems in apartment corridors (15%) and the adoption of LED holiday lighting (10%). It should be noted that this savings value applies only to the electricity used by the specified lighting appliance itself; it does not include any interactive effects with other end uses (*see Subsection 5.6.1*).

More efficient major appliances, televisions and computers account for approximately 25% of the total electricity savings in the Economic Potential Forecast. It should be noted that this savings value applies only to the electricity used by the specified appliance itself; it does not include any interactive effects with other end uses (*see Subsection 5.6.1*).

In the Economic Potential Forecast, DHW savings account for approximately 10% of the total electricity savings. Approximately 60% of the DHW savings in 2015/16 come from reduced hot water use in efficient clothes washers and dishwashers.

Space heating savings from upgrades to the building envelope and space heating systems account for approximately 10% of the total electricity savings in the Economic Potential Forecast. It is important to recognize that the 10% savings for this end use represent the reduction in space heating electricity use relative to the Reference Case. However, the actual net space heating load in the Economic Potential Forecast is greater than in the Reference Case because of the introduction of more efficient lighting and appliances, which give off less waste heat. (*See Subsection 5.6.1 for further discussion.*)

“Other” appliances and household equipment account for approximately 10% of the total electricity savings in the Economic Potential Forecast. In light of a review of recent studies that address several of the larger energy consumers in the “Other” category, the savings presented in this section are believed to be conservative. A conservative approach was employed in recognition of the significant challenges involved in capturing these savings.

5.6.1 Caveats on Interpretation of Results

A systems approach, consistent with that employed in the original CPR, was used to model the energy impacts of the efficiency upgrades presented in the preceding section. In the absence of a systems approach, there would be double counting of savings and an accurate assessment of the total contribution of the energy-efficient upgrades would not be possible. More specifically, there are two particularly important considerations:

- **More than one upgrade may affect a given end use.** For example, improved insulation reduces space heating electricity use, as does the installation of new energy-efficient windows. On their own, each measure will reduce overall space heating electricity use. However, the two savings are not additive. The order in which some upgrades are introduced is also important. In this study, the approach has been to select and model the impact of “bundles of measures” that reduce the load for a given end use (e.g., wall insulation and window upgrades that reduce the space heating load) and then to introduce measures that meet the remaining load more efficiently (e.g., a high-efficiency space heating system).
- **There are interactive effects among end uses.** For example, the electricity savings from more efficient appliances and lighting result in reduced waste heat. During the space heating season, this appliance and lighting waste heat contributes to the building’s internal heat gains, which lower the amount of heat that must be provided by the space heating system. The magnitude of the interactive effects can be significant. Based on selected building energy use simulations, a 100 kWh savings in appliance or lighting electricity use results, on average, in an increased space heating load of 42 to 54 kWh, depending on housing detachment type and geographical location.

The above considerations have important implications for the interpretation of the results presented herein. In each case, the savings are for the “bundle” of measures affecting the end use, and the interactive effects are accounted for in the end use affected. The results shown in Exhibit 5.6 for thermostat setback in apartments are particularly illustrative. In this case, temperature setback was the only space heating measure that was modelled for existing apartments; on its own, this measure would result in savings of approximately 100 GWh/yr. by 2015/16. However, the same end use, space heating, is also affected by the reduced internal gains from the more efficient appliances. The reduced internal gains increase the apartment space heating load slightly more than the thermostat setback reduces it. The resulting impact on space heating is a negative saving. In this example, however, the savings are less negative than they would have been without the thermostat setback measure. The above impacts mean that the introduction of more efficient appliances and lighting results in an energy shift among end uses. In the case of space

heating, the above impact also results in a fuel shift from electricity to natural gas due to the dominance of natural gas use for this end use.

On the other hand, this same reduction in appliance waste heat contributes to savings in air-conditioning, where applicable. In this case, however, the result is additional electricity savings, as all residential air conditioning is electric. Due to the relatively small penetration of air-conditioning in the residential sector, the impact of this interactive effect was not modelled.

6. ACHIEVABLE POTENTIAL ELECTRICITY SAVINGS

6.1 INTRODUCTION

This section presents the Residential Sector Achievable Potential electricity savings for the study period (FYs 2000/01 to 2015/16). The Achievable Potential is defined as the proportion of the savings identified in the Economic Potential Forecast that could realistically be achieved within the study period.

The remainder of this discussion is organized into the following subsections:

- Description of Achievable Potential
- Approach to the Estimation of Achievable Potential
- Results.

6.2 DESCRIPTION OF ACHIEVABLE POTENTIAL

Achievable Potential recognizes that in many instances it is difficult to induce all customers to purchase and install all the electrical efficiency technologies that meet the criteria defined by the Economic Potential Forecast. For example, customer decisions to implement energy-efficient measures can be constrained by important factors such as:

- Higher first cost of efficient product(s)
- Need to recover investment costs in a short period (payback)
- Lack of product performance information
- Lack of product availability.

The rate at which customers accept and purchase energy-efficient products will be influenced by the level of financial incentives, information and other measures put in place by BC Hydro, governments and the private sector to remove barriers such as those noted above.⁴¹

Exhibit 6.1 presents the level of electricity consumption that is estimated in the Achievable Potential scenarios. As illustrated, the Achievable Potential scenarios are "banded" by the two forecasts presented in previous sections, namely: the Economic Potential Forecast and the Reference Case. As illustrated in Exhibit 6.1, electricity savings under Achievable Potential are typically less than in the Economic Potential Forecast. Two key considerations contribute to this outcome:

- **Savings per Participant.** The bundle of measures in the Economic Potential Forecast was selected based on BC Hydro's economic criteria, not that of the customer (which has not yet been considered). Thus, the measures included in the Economic Potential Forecast may be more aggressive than those that the customer would be willing to invest in (even with BC Hydro intervention). As a result, participant electricity savings in the Economic Potential Forecast may exceed levels contained in the Achievable Potential scenarios.

⁴¹ Further discussion of market barriers facing energy efficient technologies, together with possible interventions is provided in Appendix C.

- **Rate of Market Penetration.** In the Economic Potential Forecast, efficient new technologies are assumed to fully penetrate the market as soon as it is financially attractive to do so. However, the Achievable Potential recognizes that under “real world” conditions, the rate at which customers are likely to implement new technologies will be influenced by additional practical considerations and will, therefore, occur more slowly than under the assumptions employed in the Economic Potential Forecast.

Exhibit 6.1 also shows that future electricity consumption under the Reference Case is greater than in either of the two Achievable Potential forecasts. This is because the Reference Case represents a “worst-case” situation in which there are no additional BC Hydro market interventions and hence no additional electricity savings beyond those that occur “naturally”.

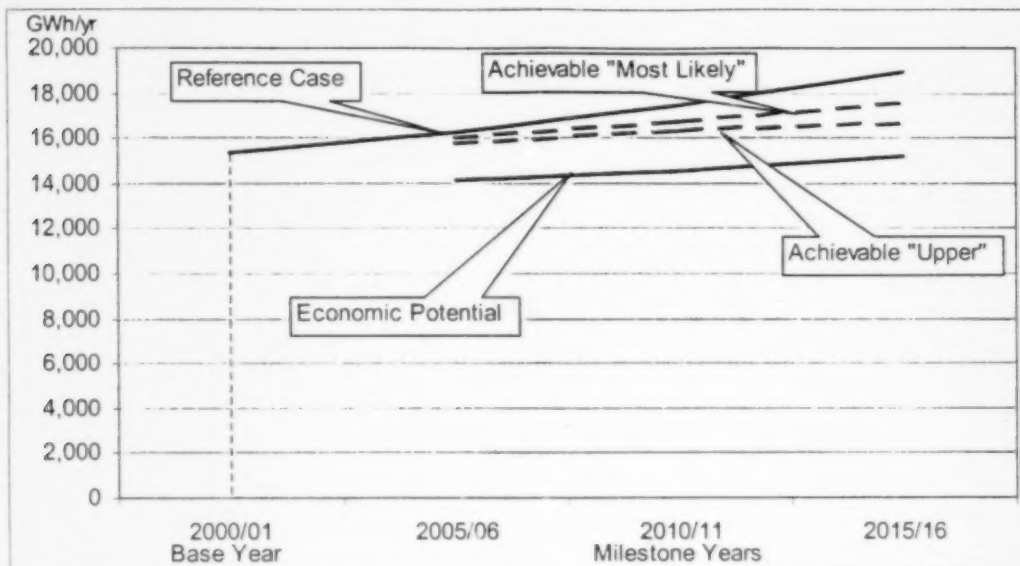
Any estimate of Achievable Potential over a 15-year period is necessarily subject to uncertainty; therefore, Exhibit 6.1 presents the achievable results as a band of possibilities, rather than a single line. For example, at the time of this study, there are a number of known external factors that could significantly influence the achievable estimates presented in this section (e.g., implications of Canada’s ratification of the Kyoto Protocol, changes to U.S. federal government energy policy and regional initiatives such as the Sustainable Region Initiative). Given the preceding considerations, two Achievable Potential scenarios are presented: “most likely” and “upper”.⁴²

- The “**Most Likely**” *Achievable Potential* assumes B.C. market conditions that are similar to those contained in the Reference Case. That is, the customers’ awareness of energy efficiency and their motivation levels remain similar to those in the recent past, technology improvements continue at historical levels and new energy performance standards continue as per current known schedules. It also assumes that BC Hydro’s ability to influence customers’ decisions towards increased investments in energy efficiency remains “roughly” in line with previous Power Smart experience.
- The “**Upper**” *Achievable Potential* assumes that B.C. market conditions become more supportive of investing in energy efficiency. For example, this scenario assumes that the ratification of the Kyoto Protocol leads to new federal government initiatives that increase customers’ awareness of energy efficiency and their motivation. These conditions also provide additional opportunities to leverage Power Smart program resources through partnering with other organizations (e.g., the federal government). It also assumes that current U.S. federal energy policy becomes more supportive of energy efficiency. This is particularly critical to assumptions about the timing and the performance levels of upgraded appliance and equipment energy performance standards or regulations.⁴³

⁴² This is the upper limit of the impact of BC Hydro initiatives. It is not the upper limits of electricity conservation.

⁴³ The estimate of customer participation rates for future Power Smart initiatives in the “Upper” scenario assumed that there would be some increase in electricity rates charged by BC Hydro. However, there was no examination of different rate designs or the possible differential impacts of different levels of rate increases or alternative rate designs.

Exhibit 6.1: Annual Electricity Consumption—Achievable Potential Relative to Reference Case and Economic Potential Forecast for the Residential Sector, (GWh/yr.)

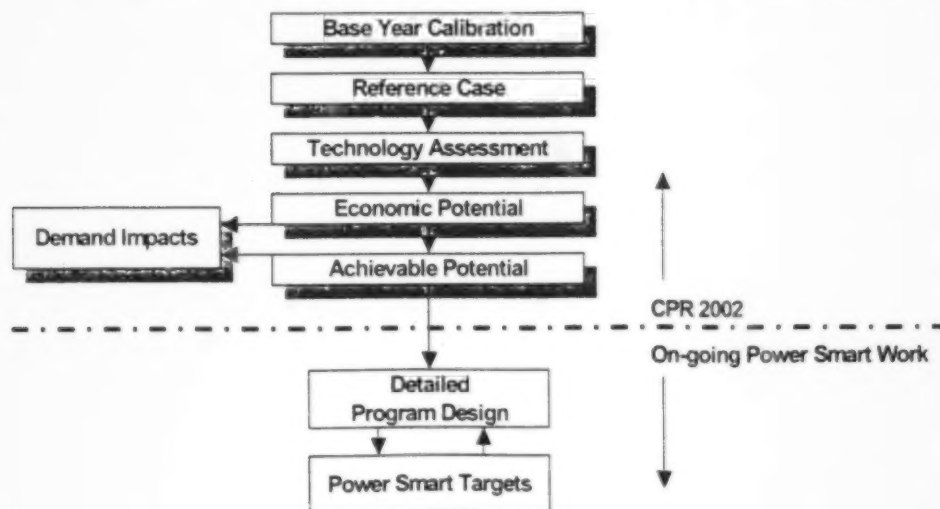


6.2.1 Achievable Potential Versus Detailed Program Design

It should also be emphasized that the estimation of Achievable Potential is not synonymous with either the setting of specific Power Smart targets or with program design. While both are closely linked to the discussion of Achievable Potential, they involve more detailed analysis that is beyond the scope of this study.

Exhibit 6.2 illustrates the relationship between Achievable Potential and the more detailed program design.

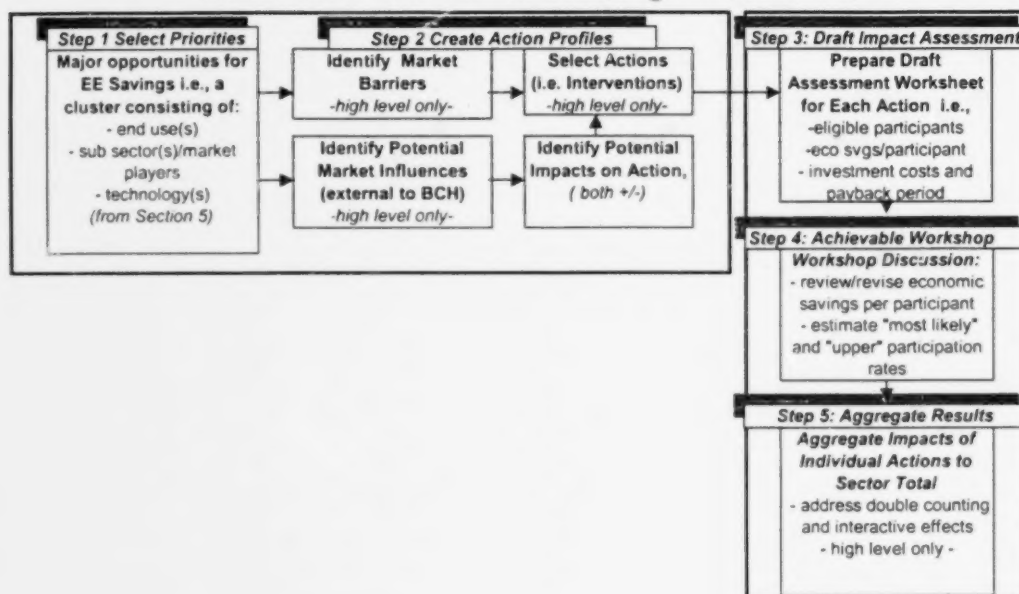
Exhibit 6.2: Achievable Potential versus Detailed Program Design



6.3 APPROACH TO THE ESTIMATION OF ACHIEVABLE POTENTIAL

Achievable Potential was estimated in a five-step approach. A schematic showing the major steps is shown in Exhibit 6.3 and each step is discussed below.

Exhibit 6.3: Flow Chart Estimating Achievable Potential



6.3.1 Step 1: Select Priorities

The first step in developing the Achievable Potential estimates required that the electricity savings opportunities identified in the Economic Potential Forecast be "bundled" into a set of Actions that would facilitate the subsequent assessment of their potential market penetration.

A summary of the selected Actions is provided in Exhibit 6.4. As illustrated, the Actions have been bundled by end use and, for each, Exhibit 6.4 shows the Action name, the target end use(s), the target subsectors and technologies, and the approximate percentage that it represents of the total residential electricity savings contained in the Economic Potential Forecast.

Exhibit 6.4: Residential Sector Actions

Action		Target End Use(s)	Target Vintage(s)	Target Segments & Technologies	% of Total Economic Savings (approx)
#	Name				
R1	Residential Lighting Efficiency	Lighting	New & Existing	• All—Incandescent to CFL • All—Holiday lights to LED • Apartment Corridors—T12 to T8 electronic	39
R2	Energy Star Appliances and Electronic Equipment	Appliances, Computers and TVs	New & Existing	• All—Refrigerators, Freezers, Clothes washers • All—Dishwashers, Computers, Colour TVs • Ceiling and ventilator fans	26
R3	Efficient Water Heating	DHW	Existing	• All—DHW tank insulation and heat trap—electric DHW • Flow restrictors and aerators	10
R4	Energy-efficient New Apartment Design	Building Envelope	New	• Apt—integrated design to 40% below current	1
R5	Efficient Blower Motors	Ventilation	New & Existing	• SFD/Duplex—ECPM blower motors—forced air systems	3
R6	Advanced Heat Pumps	Space Heating/cooling	New	• SFD/Duplex—Cold Climate Heat Pump	4
R7	Comprehensive Weatherization	Building Envelope	New & Existing	• SFD/Duplex, Row—envelope & temperature setback • SFD/Duplex, Row—window upgrades • Apartment—temperature setback • Mobile/Other—envelope & temperature setback	5
R8	Miscellaneous	Stand by losses	New & Existing	• All—electronic equipment and appliances	12

6.3.2 Step 2: Create Action Profiles

The next step involved the development of brief profiles for each of the Actions noted above in Exhibit 6.4. A sample profile for Action R1 (Residential Lighting Efficiency) is presented in Exhibit 6.5. (For profiles for the remaining Actions *see* Appendix C.)

The purpose of the Action Profiles was to provide a “high-level” logic framework that would serve as a guide for participant discussions in the Achievable Workshop (*see below*). The intent was to define a broad rationale and direction without getting into the much greater detail required of program design, which, as noted previously, is beyond the scope of this project.

As illustrated in Exhibit 6.5, each Action Profile addresses the following areas:

- **Goal**—provides a summary statement of the broad goal and rationale for the Action.

Exhibit 6.5: Sample Residential Action Profile

Action Profile R 1—Residential Lighting Efficiency
Goal: This Action will encourage replacement of existing incandescent room and holiday lighting with CFL and LED technologies in all existing and new residential dwellings. Despite increased use of CFLs, the Residential End Use Survey confirmed that incandescent lights remain the primary means of lighting in B.C. homes. This Action will also promote the retrofit of existing T12 fluorescent lighting systems with T8 electronic fluorescent systems in apartment buildings.
Target Technologies and Subsegments: • Incandescent bulbs to CFL—all subsegments • Incandescent holiday lights to LED—all subsegments • T12 fluorescent lighting to T8 electronic—Apartment corridors and common areas.
Target Stakeholder Groups: Building owners, occupants and maintenance personnel, including • Homeowners, particularly those contemplating a home renovation • Building owners who pay for operating expenditures • Housing authorities that subsidize operating costs of building occupants • Home builders • Vendors and trade allies
Key Barriers and Interventions: Experience to date indicates that the most significant barriers affecting this opportunity are: • Lack of awareness—e.g., re: the benefits of CFLs; knowledge of LEDs • Product—e.g., ability to meet customer aesthetic and functional needs (dimnable, fixture match etc) • Financing—e.g. a higher capital cost for CFLs, LEDs and T8 systems This Action will address these barriers by combining the following interventions: • Information and promotion—directed towards customers, vendors and trade allies, including in-store technical information on CFLs, LEDs • Financial incentives, such as mail in rebates for CFL and LED holiday light purchases • Standards and regulations, such as accelerated changes to provincial regulations affecting the minimum electricity performance of lamps and ballasts.
Time Frame: Start in 2003; financial incentives to 2008; standards and labeling initiatives post 2008.
Relationship to Other Actions: This Action complements activities envisioned under Actions R2.

- **Target Technologies and Subsegments**—highlights the major technologies and the subsegments where the most significant electricity savings opportunities have been identified in the Economic Potential Forecast.
- **Target Stakeholder Groups**—identifies key market players that would be expected to be involved in the actual delivery of services. The list of stakeholders shown is intended to be “indicative” and is by no means comprehensive.
- **Key Barriers and Interventions**—identifies key market barriers that are currently constraining the increased penetration of energy-efficient technologies or measures. Interventions for addressing the identified barriers are noted. Again, it is recognized that the interventions are not necessarily comprehensive; rather, their primary purpose was to help guide the workshop discussions. A listing of generalized market barriers to energy efficiency and interventions is provided in Appendix C.

- **Time Frame**—identifies the potential timing of activities with the intent of assisting workshop participants to envision possible customer participation rates.
- **Relationship to Other Actions**—identifies possible synergies with other Actions that may affect workshop participant views on possible customer participation rates.

6.3.3 Step 3: Prepare Draft Action Assessment Worksheets

A draft Assessment Worksheet was prepared for each Action Profile in advance of the Achievable Workshop. The Assessment Worksheets complemented the information contained in the Action Profiles by providing quantitative data on the potential electricity savings for each Action as well as providing information on the size and composition of the eligible population of potential participants. Electricity savings and population data were taken from the detailed modelling results contained in the Economic Potential Forecast.

A sample Assessment Worksheet for *Action R1—Residential Lighting Efficiency* is presented in Exhibit 6.6. (For worksheets for the remaining Actions *see* Appendix C.) As illustrated in Exhibit 6.6, each Action Assessment Worksheet addresses the following areas:

- **Approximate % of Action Savings**—shows the contribution of individual subsectors to the total electricity savings represented by each Action. For example, the previous Exhibit 6.4 showed that lighting accounts for about 35% of the residential electricity savings contained in the Economic Potential Forecast. The first entry in Exhibit 6.6 shows that single-family detached and duplex dwellings account for about 62% of those lighting savings.
- **Economic Savings to FY 2015/16**—shows the total economic savings, by milestone period, for the measures included in the Action. As applicable, the savings are further broken out by technology and/or end use.
- **Participant Definition**—provides the definition of “participant” that is used in subsequent portions of the worksheet to calculate electricity savings. The definition of “participant” may vary depending on the specific Action.
- **Total Applicable (Participants)**—shows the total population of potential participants that could theoretically take part in the Action. Numbers shown are from the eligible populations used in the Economic Potential Forecast.
- **Prime Target**—identifies, as appropriate, any portion of the applicable participants that offer particularly good opportunities for electricity savings under the Action.

- **Major Technologies and Contribution to Economic Savings**—provides additional detail on the composition of the economic savings for the Action. It was particularly intended to assist workshop participants in their discussions of potential participation rates.
- **Approximate Savings per Participant**—indicates the annual electricity savings (kWh/yr.) for a “typical” participant within each subsector. The purpose of this entry was to invoke a more informed discussion among workshop participants vis-à-vis the level of savings assumed in the Economic Potential Forecast and whether any adjustments were needed to account for practical considerations.
- **Savings Adjustment Factor**—provides a record of any decisions to de-rate the “optimized” savings contained in the Economic Potential Forecast to levels that better account for practical customer considerations. This entry was completed during the workshop, or in subsequent discussions with workshop participants.⁴⁴
- **Approximate CCE**—shows the approximate cost of conserved energy (CCE) for the measure(s) included within each Action. Where multiple measures are included, a weighted average value is presented. The CCE provides an indication of the relative economic attractiveness of the energy efficiency measures from BC Hydro’s perspective. For the purposes of the workshop, this information provided participants with an indication of the scope for using financial incentives to influence customer participation rates.
- **Customer Payback**—shows the simple payback from the customer’s perspective for the package of energy efficiency measures included in the Action. This information provided an indication of the level of attractiveness that the Action measures would present to customers. This provided an important reference point for the workshop participants when considering potential participation rates. When combined with the preceding CCE information, participants were able to “roughly” estimate the level of financial incentives that could be employed to increase the Action’s attractiveness to customers without making the measures economically unattractive to BC Hydro.

For example, measures having a long payback period from the customer’s perspective but having an attractive CCEs from BC Hydro’s perspective⁴⁵ provide opportunity for BC Hydro to reduce the customer’s payback by providing financial incentives. Measures having both long paybacks and relatively high CCEs do not provide the same opportunity for using financial incentives to increase their attractiveness to customers and, hence, to increase customer participation rates.

⁴⁴ It was not possible to discuss all the Action Profiles during the one-day workshop. Consequently, selected follow up discussions were held with core BC Hydro personnel after the workshop.

⁴⁵ This situation can occur with measures that have a relatively long service life.

Exhibit 6.6: Sample Worksheet: Action Profile R1—Residential Lighting Efficiency

Subsector	SFD/Duplex			Low-rise			Row			Mobile/Other			High-rise			
Approx % of Action Savings	62%			18%			7%			4%			8%			
Eco Savings (GWh/hr) to 2015/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	
	761	823	892	225	244	264	90	97	105	55	59	64	101	110	119	
Participant Definition	Dwellings			Apt. units and corridors			Dwellings			Dwellings			Apt. units and corridors			
Total Applicable Dwellings ('000s)	886	73	81	344	28	31	136	12	12	111	9	10	155	13	14	
Prime Target	All			All			All			All			All			
Major Technologies & Contribution to Economic Savings	Technology	% of Eco		Technology	% of Eco		Technology	% of Eco		Technology	% of Eco		Technology	% of Eco		
	Inc. to CFL	80%		Inc. to CFL	50%		Inc. to CFL	85%		Inc. to CFL	75%		Inc. to CFL	50%		
	Holiday/Ext.	20%		Corridor	50%		Holiday/Ext.	15%		Holiday/Ext.	25%		Corridor	50%		
Approx Svgs/Dwelling/suite	858			655			656			491			655			
Savings Adjustment Factor (if applicable)	okay			okay			okay			okay			okay			
Approx. CCE (¢/kWh)	1.7			3.6			1.7			1.7			3.6			
Approx. Customer Payback (yrs)	3.6			3.2			3.6			3.8			3.2			
Participation Rate (% of Eco svgs)	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	
Most Likely	15	30	45	15	30	45	15	30	45	15	30	45	15	30	45	
Upper	25	50	90	25	50	90	25	50	90	25	50	90	25	50	90	
Action Savings, by Year (GWh)	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	
Most Likely	114	247	401	34	73	119	13	29	47	8	18	29	15	33	54	
Upper	190	411	803	56	122	238	22	48	95	14	30	58	25	55	107	
Total Savings, by Year (GWh)													05/06		10/11	15/16
Economic Savings													1,231		1,332	1,444
Most Likely													185		400	650
Upper													308		666	1,300

- **Participation Rates**—show the percentage of economic savings that workshop participants concluded could be achievable in each milestone period. For example, Exhibit 6.6 shows a participation rate of 15% (most likely) for lighting in single-family dwellings/duplexes by the year FY 2005/06. This means that by FY 2005/06, 15%, or 114 GWh/yr. of the potential 761 GWh/yr. of savings contained in the Economic Potential forecast will be achieved.

As noted in the introduction to this section, two achievable levels are shown: “most likely” and “upper”. As noted previously, it was not possible to cover all the Action during the workshop; consequently, some of the values shown were developed in collaboration with BC Hydro program personnel following the workshop.

- **Action Savings by Year**—shows the calculated electricity savings in each milestone period based on the savings and participation rates presented in the preceding rows of the Worksheet.

6.3.4 Step 4: Achievable Workshop

The most critical step in developing the estimates of Achievable Potential was a one-day Achievable Workshop that was held on November 18. Workshop participants consisted of core members of the client and consultant team as well as key program and technical personnel from BC Hydro’s residential Power Smart programs. Together, participating BC Hydro personnel brought to the workshop many years of experience in designing and delivering programs for energy efficiency within the B.C. market.

The purpose of this workshop was twofold:

- To promote discussion between the consultants and the Power Smart personnel regarding the identified opportunities for energy efficiency.
- To promote discussions among the BC Hydro personnel themselves related to how much of the identified economic savings could realistically be achieved over the study period.

The discussion of each Action Profile began with a brief consultants presentation. The floor was then opened to participant discussion of the key factors affecting each of the market segments and technical opportunities contained in the Action Profile and accompanying Worksheet.

Following discussion of the broad market and intervention conditions affecting the Action, workshop participant views were recorded on “most likely” and “upper” customer participation rates. General agreement was sought on rates to be carried forward into the analysis; estimates were rounded down for “most likely” and rounded up for “upper” estimates.

As noted earlier, it was not possible to fully address all Actions in the one-day workshop. Consequently, the workshop focussed on the “big ticket” Actions and follow up discussions were held with BC Hydro program personnel after the workshop. The values

shown in the attached appendices and in the following summary tables incorporate the results of the two sets of inputs.

6.3.5 Step 5: Aggregate Action Results

The final step involved aggregating the results of the individual Actions to provide a view of the potential achievable savings for the total residential sector. In reviewing the results, readers are reminded that “double counting” of savings has been avoided as the Worksheets use estimated savings from the Economic Potential forecast.⁴⁶ However, for the same reason, the accounting of interactive effects means that there is some shifting of savings among end uses. This is most significant in the case of appliances and space heating. More efficient appliances create less waste heat, which in turn increases space heating loads. The result is that some of the energy savings provided by the Weatherization Action are masked by the increased space heating load that occurs from the introduction of more efficient appliances (*see* Section 5.6.1 for further discussion).

6.4 RESULTS

Exhibit 6.7 (by Action) and Exhibit 6.8 (by Segment) present a summary of the Achievable Savings Potential under the “most likely” and “upper” scenarios.⁴⁷ The savings values shown are relative to the Reference Case and represent the total annual cumulative electricity savings at the end of each milestone year.⁴⁸ For example, Exhibit 6.7 shows that Action R1—Lighting will achieve an annual saving of 185 GWh/yr. by FY 2005/06 under the “most likely” scenario. This annual savings increases to 400 GWh/yr. by 2010/11, again under the “most likely” scenario.

As illustrated in the following exhibits, savings under the Achievable Potential scenarios are significantly less than the Economic Potential savings presented previously in Section 5. Overall, Achievable savings by FY 2015/16 represent approximately 37% (most likely) and 62% (upper) of the Economic Potential savings. The primary reason for the gap between the Achievable and the Economic savings is the different criteria that are used in the two cases. The Economic Potential savings are based on criteria that reflect BC Hydro’s investment requirements and that are not constrained by market barriers. These criteria are very different than those that homeowners/tenants use to make investment decisions. For example, the package of lighting efficiency measures shown in Exhibit 6.6 for single-family homes meet the criteria defined in the Economic Potential scenario (i.e., a CCE less than \$0.06/kWh); therefore, the Economic Potential scenario assumes that the lighting measures fully penetrate the market. However, Achievable Potential savings recognize that even with utility incentives, it is unlikely that all customers will be willing to pay the higher first cost commanded by compact fluorescent lamps. Similarly, the Achievable Potential estimates recognize that market barriers such as split landlord/tenant incentives or customer concerns related to the lighting aesthetics provided by compact fluorescent lamps provide further challenges to customer participation. Given that this study’s results are intended to provide a solid basis for BC Hydro’s DSM investments, assumptions about customer willingness to invest have necessarily taken these real life factors into consideration and, in some cases, the results may be conservative.

⁴⁶ These results are based on building energy use simulation software that address interactive effects.

⁴⁷ Results are reported at the customer’s point of use and do not include line losses.

⁴⁸ Savings shown for FY 2005/06 include the impacts of new Power Smart activities implemented since the base year of FY 2000/01.

Exhibit 6.7: Summary of Achievable Savings, by Action—"Most Likely" & "Upper" Scenarios*

Service Region Action	Annual Electricity Savings (GWh/vr), by Milestone Year					
	2005/06		2010/11		2015/16	
	Most Likely	Upper	Most Likely	Upper	Most Likely	Upper
R1 - Lighting	185	308	400	666	650	1,300
R2 - Appliances	101	176	274	418	504	699
R3 - Water Heating	1	2	1	3	2	4
R4 - Efficient New Apartments	0	0	2	3	8	11
R5 - Blower Motors	1	1	14	25	70	85
R6 - Heat Pumps	1	2	3	5	6	12
R7 - Weatherization	5	11	10	33	47	62
R8 - Standby Losses	0	3	15	31	47	93
Total BC Hydro	293	502	719	1,184	1,333	2,265
Lower Mainland	Annual Electricity Savings (GWh/vr), by Milestone Year					
	2005/06		2010/11		2015/16	
	Most Likely	Upper	Most Likely	Upper	Most Likely	Upper
R1 - Lighting	114	190	246	410	400	801
R2 - Appliances	57	100	154	235	282	392
R3 - Water Heating	0	0	0	1	1	1
R4 - Efficient New Apartments	0	0	0	0	1	2
R5 - Blower Motors	0	1	9	15	43	51
R6 - Heat Pumps	0	0	0	1	1	2
R7 - Weatherization	1	2	2	5	7	9
R8 - Standby Losses	0	2	8	17	25	50
Total Lower Mainland	173	294	419	684	760	1,307
Vancouver Island	Annual Electricity Savings (GWh/vr), by Milestone Year					
	2005/06		2010/11		2015/16	
	Most Likely	Upper	Most Likely	Upper	Most Likely	Upper
R1 - Lighting	36	60	78	130	127	255
R2 - Appliances	22	38	60	91	110	153
R3 - Water Heating	0	1	1	1	1	2
R4 - Efficient New Apartments	0	0	1	2	6	8
R5 - Blower Motors	0	0	2	4	12	14
R6 - Heat Pumps	1	1	2	4	4	9
R7 - Weatherization	4	7	7	23	33	44
R8 - Standby Losses	0	1	4	7	11	22
Total Vancouver Island	63	108	155	264	305	507
Interior	Annual Electricity Savings (GWh/vr), by Milestone Year					
	2005/06		2010/11		2015/16	
	Most Likely	Upper	Most Likely	Upper	Most Likely	Upper
R1 - Lighting	35	58	75	125	122	244
R2 - Appliances	22	38	60	92	111	154
R3 - Water Heating	0	0	0	1	0	1
R4 - Efficient New Apartments	0	0	0	0	1	2
R5 - Blower Motors	0	0	3	6	16	19
R6 - Heat Pumps	0	0	0	1	1	2
R7 - Weatherization	1	2	2	5	7	9
R8 - Standby Losses	0	1	3	7	10	21
Total Interior	58	100	145	237	268	451

*Results are measured at the customer's point of use and do not include line losses.

Exhibit 6.8: Summary of Achievable Savings, by Segment—"Most Likely" & "Upper" Scenarios*

Service Region Segment	Annual Electricity Savings (GWh/vr), by Milestone Year					
	2005/06		2010/11		2015/16	
	Most Likely	Upper	Most Likely	Upper	Most Likely	Upper
SFD/Duplex	191	325	481	793	912	1,514
Row	21	37	53	87	96	166
Low Rise	46	79	100	165	173	317
High Rise	21	36	47	78	84	150
Mobile/Other	15	26	38	62	68	119
Total BC Hvdro	293	502	719	1,184	1,333	2,265
Lower Mainland						
Annual Electricity Savings (GWh/vr), by Milestone Year						
2005/06		2010/11		2015/16		
Most Likely	Upper	Most Likely	Upper	Most Likely	Upper	
SFD/Duplex	112	191	280	458	520	874
Row	13	21	31	50	55	96
Low Rise	27	46	59	96	99	183
High Rise	12	21	28	45	48	86
Mobile/Other	9	15	22	36	39	68
Total Lower Mainland	173	294	419	684	760	1,307
Vancouver Island						
Annual Electricity Savings (GWh/vr), by Milestone Year						
2005/06		2010/11		2015/16		
Most Likely	Upper	Most Likely	Upper	Most Likely	Upper	
SFD/Duplex	41	70	104	177	209	339
Row	5	8	11	19	22	37
Low Rise	10	17	22	37	40	71
High Rise	4	8	10	17	19	34
Mobile/Other	3	6	8	14	16	27
Total Vancouver Island	63	108	155	264	305	507
Interior						
Annual Electricity Savings (GWh/vr), by Milestone Year						
2005/06		2010/11		2015/16		
Most Likely	Upper	Most Likely	Upper	Most Likely	Upper	
SFD/Duplex	38	65	97	158	184	301
Row	4	7	11	17	19	33
Low Rise	9	16	20	33	35	63
High Rise	4	7	10	16	17	30
Mobile/Other	3	5	8	12	14	24
Total Interior	58	100	145	237	268	451

*Results are measured at the customer's point of use and do not include line losses.

Exhibits 6.9 (most likely) and 6.10 (upper) show the estimated electricity savings in the milestone year 2015/16 for each Action in the form of supply curves that also incorporate the Cost of Conserved Energy (CCE). This view, therefore, shows the level of electricity savings that could be achieved under various investment thresholds.

Exhibit 6.9: Supply Curve for Residential Actions “Most Likely” Scenario, 2015/16

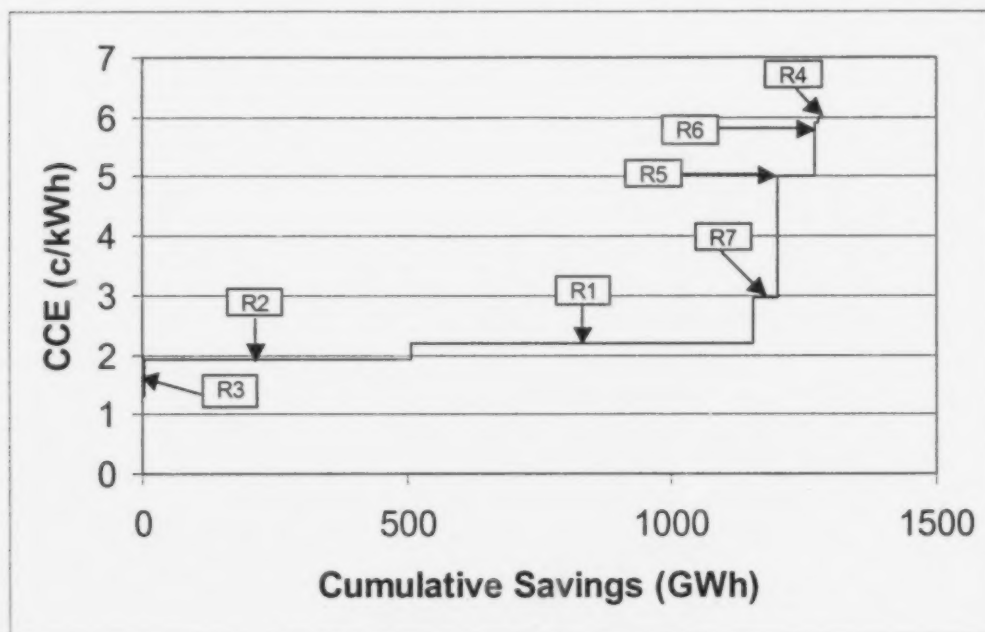
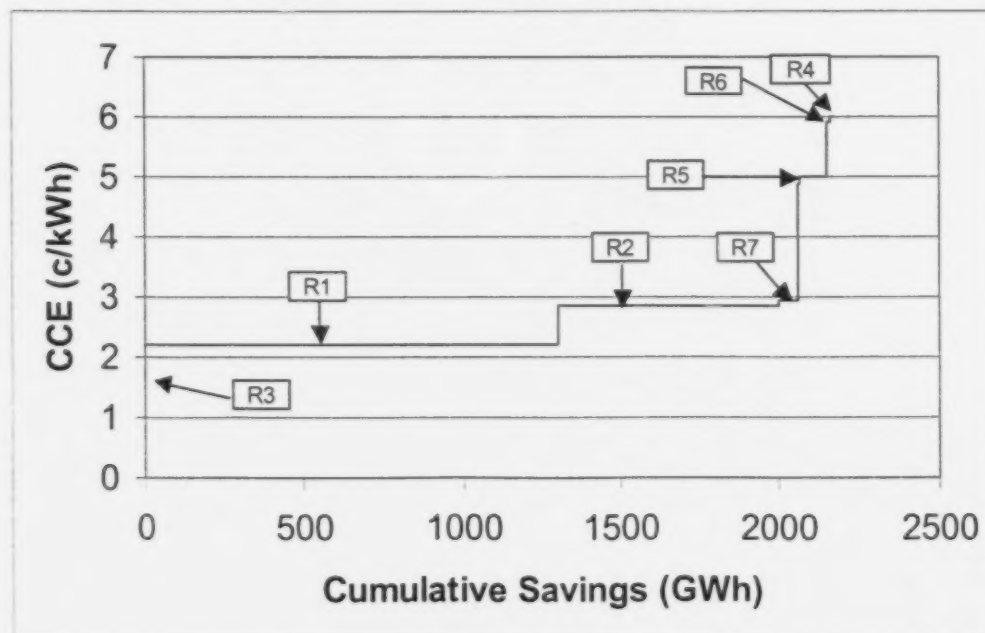


Exhibit 6.10: Supply Curve for Residential Actions “Upper” Scenario, 2015/16



7. DEMAND IMPACTS

7.1 INTRODUCTION

This section presents an assessment of the demand savings that would occur as a result of the electricity savings contained in each of the three preceding potentials for energy efficiency, namely:

- Economic Potential Forecast
- "Most Likely" Achievable Potential
- "Upper" Achievable Potential.

In each case, both electricity and demand savings are defined relative to the Reference Case presented previously in Section 3. It should be emphasized that the CPR is not a demand reduction study, per se. Rather, the focus is on the demand impacts of the measures for energy efficiency contained in the Economic and Achievable Potential forecasts. It is recognized that there are numerous other technologies and load control strategies that can be used to reduce peak demand requirements. These latter technologies and strategies are beyond the scope of this study.

The discussion in this section is organized as follows:

- Overview of BC Hydro System Load Profiles
- BC Hydro Annual Demand Periods Used in this CPR
- Derivation of Demand Impacts
- Presentation of Results.

7.2 OVERVIEW OF BC HYDRO SYSTEM LOAD PROFILES

Exhibit 7.1 shows BC Hydro's load profiles, at the level of both total system and individual sector, for an average winter weekday. The winter period of December and January is when the BC Hydro system typically experiences its highest levels of electricity demand and, therefore, is the primary focus of this portion of the study. As illustrated in Exhibit 7.1, the maximum total system demand is approximately 8,000 MW^{49,50} on an average winter day. It can also be seen in Exhibit 7.1 that the weekday load increases during the 16-hour period from 6 a.m. to 10 p.m.

The residential sector, which is the focus of this section, accounts for about 3,500 MW, or 44% of the total system load on a typical winter weekday; it is also the major contributor to the maximum daily peak demand, which typically occurs between 5 p.m. and 6 p.m.

⁴⁹ The load profiles presented in this section were derived to be representative of typical daily winter loads within the different regions and sectors of BC Hydro's service area and include line losses. At this disaggregated level data have been approximated using a sample of metered sites that are assumed to characterize the sectors involved. Actual metered data are not available at this level. These load profiles are intended for use only in the context of this study.

⁵⁰ BC Hydro's winter system peak is close to 9,000 MW; 8,000 MW is intended to represent a "typical" winter day.

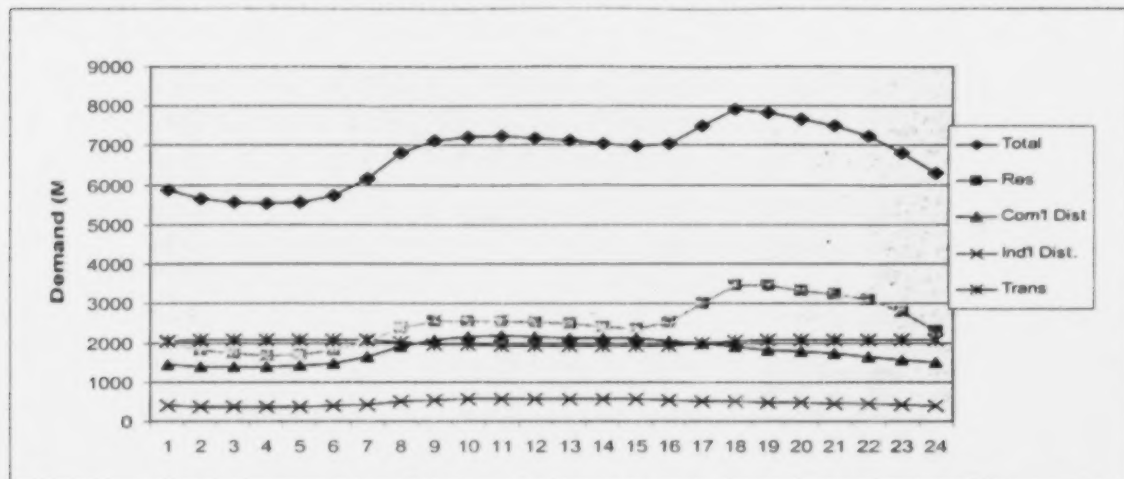
Exhibit 7.1: Average Winter Weekday Load Profile, Total BC Hydro System, (MW)

Exhibit 7.2 shows that the shape of the daily residential load profiles is similar in each of the three service regions, with the Lower Mainland accounting for slightly more than 50% of the total.

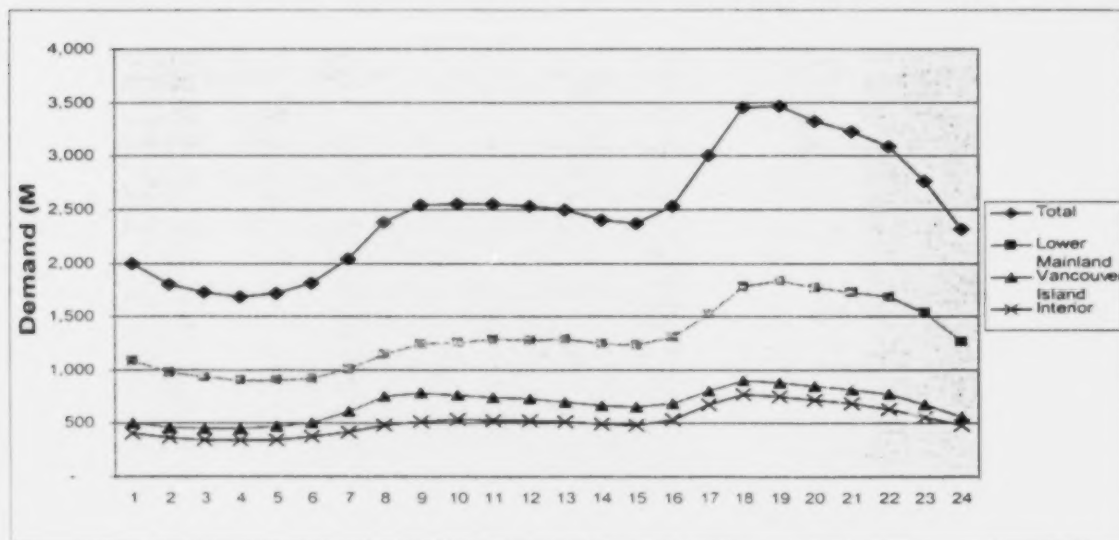
Exhibit 7.2: Average Winter Weekday Load Profile, Residential Sector, (MW)

Exhibit 7.3 shows that the ratio of “average” 16-hour weekday demand to “maximum” demand is approximately 80% for the total system. This ratio is moderately higher in the Vancouver Island service region than in the other service regions due to the greater incidence of electric space heating in this service region.

Exhibit 7.3: Comparison of “16-hour Average” and “Peak” Demand (MW) in the Residential Sector

Average Winter Day	Total BCH System	Lower Mainland	Vancouver Island	Interior
Maximum Peak Demand—Residential Sector* (MW)	3,468	1,839	896	771
% of Total (approximate)	100%	53%	26%	22%
Av. 16-hr. Demand—Weekday 6 a.m.–10 p.m. (MW)	2,747	1,412	756	579
Ratio (%):				
Average 16-hr. Demand/Maximum Peak Demand	79.2%	76.8%	84.4%	75.1%

*Regional maximum peak demands do not occur at precisely the same instant; consequently, regional maximum peaks do not add up precisely to the maximum total BC Hydro system peak.

7.3 BC HYDRO ANNUAL DEMAND PERIODS USED IN THIS CPR

Three demand periods were defined for this CPR. They are shown in Exhibit 7.4. As illustrated, the on-peak period selected for this CPR is weekdays from 6 a.m. to 10 p.m. during the months of December and January (referred to as the Winter, On-peak). Weekends and the hours from 10 p.m. to 6 a.m. during the months of December and January are off-peak (referred to as the Winter, Off-peak). The remaining hours of the year are considered to also be off-peak and are referred to as the Shoulder period. The same demand period definitions are used in each of the three service regions: Lower Mainland, Vancouver Island and the Interior.

Exhibit 7.4: BC Hydro Annual Demand Periods for CPR 2002

Period	Months	Days	Hours	Annual Total	
				Hours	%
Winter, On-peak	December 1 to January 31	Monday to Friday, inclusive	6 a.m.–10 p.m.	709	8.1
Winter, Off-peak	December 1 to January 31	Monday to Friday	10 p.m.–6 a.m.	779	8.9
		Saturday, Sunday	All hours		
Remaining	Feb. 1 to November 30	All days	All hours	7,272	83
Total				8,760	100

7.4 DERIVATION OF DEMAND IMPACTS

The CPR analysis to date has been focussed exclusively on electricity savings. The following discussion outlines the methodology employed to derive demand impacts from the electricity values. (For additional detailed data see Appendix D.)

Three steps were used to derive the demand impacts from the electricity consumption values contained in the three Potential estimates. They are listed below and are discussed in the following paragraphs:

- Annual base year electricity consumption was distributed among the three demand periods, by building segment and end use
- Average on-peak demand was calculated for the base year and compared with available utility data
- The on-peak electricity-to-demand ratios calculated for the base year were applied to the remaining forecast periods and Potential scenarios.

7.4.1 Distribution of Annual Base Year Electricity Use

Exhibit 7.5 provides a sample distribution of annual electricity consumption among the three BC Hydro demand periods. The distribution shown in Exhibit 7.5 is organized by end use and is for single-family detached/duplex dwellings in the Lower Mainland.

Exhibit 7.5: Sample Distribution of Annual Electricity Use, by Demand Period, for Single-family Detached/Duplex Dwellings, Lower Mainland, (%)*

Enduse	Annual Electricity Distribution			
	Winter Peak	Winter Off-Peak	Shoulder	Total (check)
SFD/Duplex				
Heating	11%	19%	70%	100%
Vent.	11%	19%	70%	100%
DHW	13%	8%	79%	100%
Cook.	11%	7%	82%	100%
Refrig.	8%	9%	83%	100%
Freezer	8%	9%	82%	100%
Dish.	11%	7%	82%	100%
Washer	14%	5%	81%	100%
Dryer	12%	6%	82%	100%
Micro.	13%	7%	81%	100%
Computer	10%	7%	83%	100%
Light.	15%	10%	75%	100%
ColourTV	10%	7%	83%	100%
Other	10%	7%	83%	100%
Total				

* Differs due to rounding.

Two tasks are required to generate the data shown in Exhibit 7.5. They are as follows:

- Distribute annual end use electricity consumption between the December–January period and the remaining 10 months of the year.
- Allocate the December–January consumption between the Winter on- and off-peak periods.

The following discussion uses the “freezer” end use to demonstrate the approach used to generate the data shown in Exhibit 7.5.

- The first task was to determine the proportion of annual freezer electricity consumption that typically occurs during the winter peak months of December and January versus the remaining 10 months of the year. Fortunately, a recent BC Hydro study⁵¹ was able to provide metered load profile data for freezers. In this case, the BC Hydro load data showed that freezer electricity use is distributed approximately evenly through the 12 months of the year. The winter period of December 1 to January 31 inclusive accounts for approximately 17% of the annual hours; therefore, as illustrated in Exhibit 7.5, 17% of total annual freezer electricity use was allocated to the winter period of December and January (Winter On- and Off-peak). The other 83% freezer annual electricity use was allocated to the remaining 10 months of the year.
- Once annual freezer electricity use was distributed between winter and shoulder demand periods, the next task was to allocate the winter portion (e.g., the 17%) between the on-peak and off-peak periods. As in the preceding task, the distribution between winter on- and off-peak drew on the BC Hydro load data. As the load profile data show that freezer electricity use is largely unaffected by time of day, the annual freezer electricity consumption was distributed between the on- and off-peak periods in proportion to the number of hours in each period. In this case, it is 8.9% in the off-peak period and 8.1% in the on-peak period.

The above process was applied to each of the remaining end uses and building segments.⁵² The same end use distributions were used in each of the three services areas, with the exception of space heating and ventilation.⁵³ Data for space heating (including ventilation)⁵⁴ and lighting were not included in the BC Hydro study and, therefore, were derived from secondary sources. Further discussion of the approach to these end uses is provided below.

□ Space Heating

The distribution of space heating (and ventilation) electricity required the same two tasks as noted above. First, electricity use was distributed between the winter and shoulder peak periods. In the absence of BC Hydro metered data, this was done on the basis of the percentage of heating degree days represented by the December and January periods. In the case of the Lower Mainland, weather data for Vancouver were used; these data showed that 30% of Lower Mainland's heating degree days occur in the months of December and January. Therefore, as shown in Exhibit 7.2, heating and ventilation electricity use has been allocated accordingly, with 30% allocated to the winter period and the remaining 70% allocated to the shoulder period.

The next task was to allocate the winter period consumption between the on- and off-peak periods. For this study, a heating ratio for night/day of 50% was assumed, which

⁵¹ BC Hydro, *Residential End Use Load Information*, August 2002.

⁵² DHW is an interesting exception; although usage patterns remain relatively constant, electricity requirements increase because the temperature of the source water is lower in this period.

⁵³ BC Hydro load profile data were available and were used for all the end uses, except for heating, lighting and ventilation. In some cases sample sizes were small which is expected to contribute to the minor variations shown.

⁵⁴ Ventilation electricity use is primarily for furnace fans.

was based on previous work in this area by study team personnel.⁵⁵ Their work concluded that daily space heating loads were biased towards the night-time hours. This was due to three factors:

- Night temperature setback was less widespread in homes with electric baseboard heating due to slower heat recovery and multiple thermostats;
- Outside temperatures were at their coldest; and
- Internal heat gains from lights, occupants and appliances (e.g., televisions, computers etc.) were at their lowest.

The final distribution between the on- and off-peak periods was further weighted by the ratio of daytime (i.e., weekend days and night-time hours). The net effect being that annual space heating and ventilation consumption was allocated 11% and 19% to winter on- and off-peak periods, respectively.

A similar approach was used in each service region. Victoria weather data were used for Vancouver Island and Kamloops weather data were used for the Interior. The same distribution of on- and off-peak heating and ventilation electricity consumption was used for all three service regions.

□ Lighting

The above approach was also applied to lighting. The allocation of lighting hours between Winter and the shoulder 10 months was biased towards the Winter period. An estimated value of 25% was used. This recognized two factors:

- Lighting use in the period is increased relative to other periods due to the shorter hours of daylight; and
- Virtually all the holiday lighting load occurs in the winter period.

The allocation between on- and off-peak winter periods was estimated to be 60% and 40%, respectively. This estimate was based on

- Weekday lighting use is split approximately 90/10 between on- and off-peak periods; and
- Weekend use is all off-peak.

⁵⁵ Energy Center of Wisconsin, Madison; *Wisconsin's Statewide Technical and Economic Potential*; ECW Publication Number 119-1.

7.4.2 Calculate Base Year Average On-Peak Demand

Once the preceding steps were completed, the total amount of electricity consumption in the winter on-peak period was calculated. Given that the total number of hours for the on-peak period is also known (i.e., 709 hours), it is also possible to calculate the average demand for each end use during the on-peak period using the formula below:

$$\text{Average end-use on-peak demand} = \frac{\text{Total end-use electricity use} \times \text{On-peak \%} \times (1 + \text{line losses})}{\text{Hours in on-peak period}}$$

The above calculation was repeated for each combination of dwelling type and end use and aggregated to obtain a total residential demand for each service region. Because the calculation begins with actual electricity use in the period, diversity is accounted for. Similarly, as the energy savings are calculated at the customer level, line losses need to also be added in. The same line losses of 7%⁵⁶ (4% distribution losses and 3% area transmission) used in previous sections of this report were also used in this calculation.

Exhibit 7.6 shows a sample calculation of average on-peak demand for single-family detached/duplex dwellings in Lower Mainland.

Exhibit 7.6: Sample Calculation of "Average On-peak Demand" (MW)* for Single-family Detached/Duplex Dwellings, Lower Mainland**

Enduse	Annual Electricity Distribution				Annual Electricity Use (Gwh)—Ref. Case				Average Demand in Winter Peak (MW)			
	Winter Peak	Winter Off-Peak	Shoulder	Total (check)	2000/01	2005/06	2010/11	2015/16	2000/01	2005/06	2010/11	2015/16
SFD/Duplex												
Heating	11%	19%	70%	100%	856	917	987	1,067	146	157	169	182
Vent.	11%	19%	70%	100%	223	244	267	293	38	42	46	50
DHW	13%	8%	79%	100%	202	210	221	233	39	40	42	45
Cook.	11%	7%	82%	100%	283	301	322	345	47	50	54	58
Refrig.	8%	9%	83%	100%	509	470	445	431	65	60	57	55
Freezer	8%	9%	82%	100%	253	219	181	162	32	28	23	21
Dish.	11%	7%	82%	100%	35	36	37	39	6	6	6	7
Washer	14%	5%	81%	100%	33	32	32	33	7	7	7	7
Dryer	12%	6%	82%	100%	380	388	398	415	69	70	72	75
Micro.	13%	7%	81%	100%	75	80	86	93	14	16	17	18
Computer	10%	7%	83%	100%	60	74	85	101	9	11	13	16
Light.	15%	10%	75%	100%	798	847	904	968	181	192	205	220
ColourTV	10%	7%	83%	100%	445	478	515	557	69	74	79	86
Other	10%	7%	83%	100%	919	986	1,063	1,149	142	152	164	177
Total					5,071	5,282	5,544	5,888	865	905	954	1,016

* Includes line losses @ 7%. "On-peak" is weekdays from 6 a.m. to 10 p.m. during the months of December and January.

** Differs due to rounding.

The calculated results for the base year were compared with BC Hydro's estimated data. The calculated results were 2,664 MW, which is within 3% of the BC Hydro 16-hour average on-peak demand values shown previously in Exhibit 7.3. As the BC Hydro values shown earlier in this section were intended to be "indicative" for a "typical" day rather than a direct calibration with the CPR data, the results were considered to be in good agreement and no further reconciliation was carried out.

⁵⁶ This approach omits bulk transmission losses of 5%; however, this is consistent with the approach being applied to other possible electricity options, such as small-scale renewable electricity. It is also consistent with the general assumption that the most likely future electricity supply options will occur at the regional levels rather than at remote sites, such as the historical large-scale hydroelectric developments.

7.4.3 Calculate Demand Impacts for Remaining Forecast Years and Scenarios

The electricity end use distributions employed in the base year were then applied to each of the milestone periods in the Reference Case. As none of the energy savings in either the Economic Potential forecast or the Achievable Potential scenarios affect time of use, the same distributions were also used in those applications. The results are shown in the next subsection.

7.5 PRESENTATION OF RESULTS

This section presents the estimated demand savings in two exhibits:

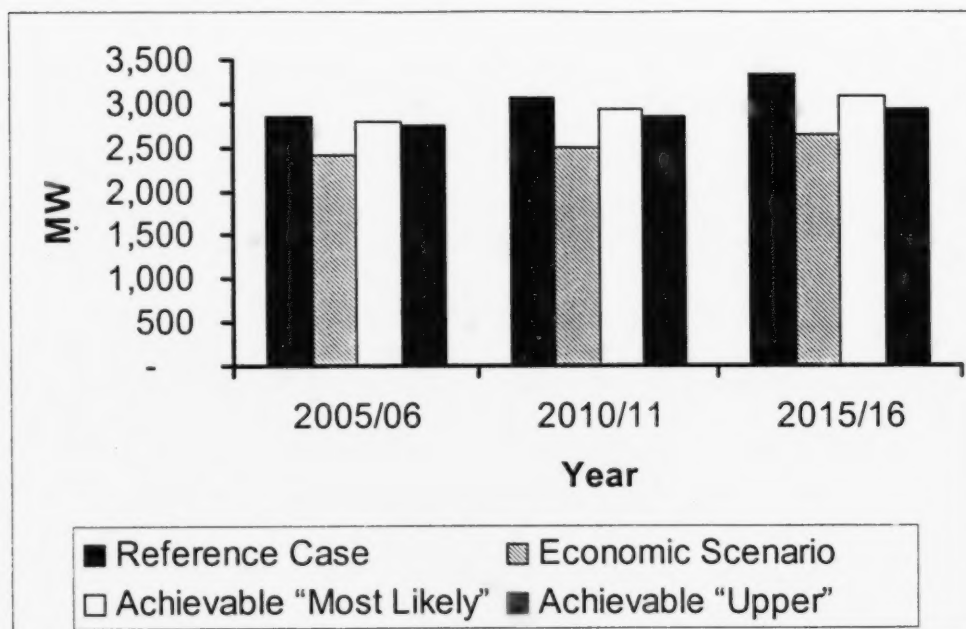
- Exhibit 7.7 illustrates the average on-peak demand estimates for the Reference Case as well as the estimated on-peak demand savings for the Economic Potential, "most likely" Achievable and "upper" Achievable Potential forecasts. The results are shown, by milestone year, for both the total BC Hydro system and for the individual service regions.
- Exhibit 7.8 shows a summary of the average on-peak demand for each scenario in graphic form.

Exhibit 7.7: Average On-peak Demand (MW)* versus Reference Case for Residential Sector Modelled Results

Service Region	Milestone Year	On-peak Demand Reference Case (MW)	On-peak Demand Economic Potential (MW)	On-peak Demand Savings Relative to Reference Case					
				Economic		Achievable "Most Likely"		Achievable "Upper"	
				MW	%	MW	%	MW	%
Total BC Hydro	Base Year	2,664							
	2005/06	2,843	2,415	427	15%	51	2%	88	3%
	2010/11	3,064	2,504	560	18%	126	4%	207	7%
	2015/16	3,323	2,633	690	21%	234	7%	398	12%
Lower Mainland	Base Year	1,406							
	2005/06	1,501	1,263	237	16%	28	2%	49	3%
	2010/11	1,612	1,314	299	19%	67	4%	110	7%
	2015/16	1,748	1,388	360	21%	122	7%	208	12%
Vancouver Island	Base Year	702							
	2005/06	747	642	104	14%	12	2%	22	3%
	2010/11	812	665	148	18%	33	4%	55	7%
	2015/16	885	696	189	21%	64	7%	109	12%
Interior	Base Year	556							
	2005/06	595	510	86	14%	10	2%	18	3%
	2010/11	639	526	113	18%	26	4%	42	7%
	2015/16	690	549	140	20%	48	7%	81	12%

* Includes line losses @ 7%. Regional numbers may not add exactly to total for BC Hydro system due to rounding.
 "On-peak" is weekdays from 6 a.m. to 10 p.m. during the months of December and January.

Exhibit 7.8: Average On-peak* Demand (MW) by Scenario and Milestone Year for BC Hydro Total Residential Sector



* Includes line losses @ 7%. "On-peak" is weekdays from 6 a.m. to 10 p.m. during the months of December and January.

8. ADDITIONAL TECHNOLOGIES

8.1 INTRODUCTION

In the introductory section to this report, Exhibit 1.1 presented the full range of technologies that were identified by the study team for consideration. The introduction also noted that technologies shown in Exhibit 1.1 were organized into two groups:

- *Electrical-efficient technologies that are commercially available today, or will be available by 2005.* These technologies are the primary focus of this study.
- *Electrical-efficient technologies that are not commercially available today but are expected to become available after 2005 but before the end of the study period.* These emerging technologies have not yet been included in this study. They are addressed in a qualitative manner in this section.

In addition, the introductory section also noted that there are numerous other technologies that could contribute to B.C.'s electricity future but are not included in this study as they are outside the agreed scope. For example, technologies such as advanced two-way thermostats and thermal electricity storage provide an opportunity to reduce peak demand; however, consideration of specific load control technologies was outside the scope of this study. Similarly, technologies that control or shift demand for electricity or represent alternative sources of electricity supply are outside of the scope of this study. The use of direct load control technologies is an example of the former group of excluded technologies while solar thermal or photovoltaic technologies provide examples of the latter group. The exclusion of both groups of technologies does not imply any judgment on their potential contribution—only that the limits of time and resources required that this study limit its focus to those technologies that met the selection criteria noted above.⁵⁷

Based on client discussions held in the early stages of the study, the following emerging technologies were selected for review:

- 2-Photon lamp
- Aerogel glazings
- Advanced refrigeration technologies:
 - Magnetic refrigeration
 - Thermo-acoustic refrigeration
 - Linear compressors.

The remainder of this section provides a brief discussion of the above technologies. In each case the discussion provides a brief description of the technology, including: its current development status and forecast dates for commercial introduction; an estimate of improvement in its energy-efficient over conventional technology; and, an estimate of its potential CPR impacts (e.g., how significant are the potential additional electricity savings?)

⁵⁷ It is also recognized that additional technologies, not currently envisioned, may emerge over the study period that will provide further opportunities for electrical efficiency.

8.2 TWO-PHOTON LAMP

8.2.1 Technology Description

Fluorescent lighting systems employing lamps with two-photon phosphors (two visible per one ultraviolet) have been discussed as a concept for more than a decade. However, the US DOE has now included them in their most recent lighting "Technology Roadmap" as an "intermediate target technology", which means that the DOE expects early commercial availability to occur in the next 5 to 10 years. This technology, which consists of new phosphor materials, electrode materials and ballast designs, promises to increase lighting efficacy levels into the range of 180 to 230 lumens/watt, which is about twice the levels currently available.

8.2.2 Potential CPR Impacts

Due to the significance of lighting electricity use in the residential sector and the magnitude of the savings provided over current technology, the market availability of the two-photon lamp systems could provide significant additional potential electricity savings.

8.3 AEROGEL GLAZINGS

8.3.1 Technology Description

Aerogel is a transparent material that looks like glass, insulates better than mineral wool and is more heat resistant than aluminum making it suitable for use in many potential applications, including as a double pane window fill. Aerogel is one of the few existing materials that are both transparent and porous. It can be formed into almost any useful shape and can be inexpensively manufactured.

There are a number of companies in the US currently working on developing this technology for different applications. They include Nanopore, Aspen Systems, Ocellus, Cabot Corp., and the TASSI Company. Use of aerogel for windows will not be possible until researchers find a way to clear them of their slightly hazy blue appearance.

Silica aerogel as a double pane window fill performs to R-20 in a 90% vacuum, in contrast with today's best performance of around R-6.⁵⁸ In the commercial sector, the higher thermal performance provided by the aerogel glazings would result in significantly lower heating and cooling loads with consequent reductions in heating and cooling electricity use.

⁵⁸ Aerogel: *Energy Efficient Material for Buildings*, Center for Building Science News, LBL, 1995.

8.3.2 Potential CPR Impacts of Aerogel Glazings

Aerogel glazings could provide substantial heating and cooling load reductions. These end uses account for approximately 20% of current residential sector electricity use in British Columbia. Consequently, their potential overall impact on the electricity savings presented in the preceding sections would also be significant.

8.4 ADVANCED REFRIGERATION TECHNOLOGIES

This category includes three emerging refrigeration technologies as follows:

- Magnetic refrigeration
- Thermo-acoustic refrigeration
- Linear compressors.

8.4.1 Magnetic Refrigeration

Compounds of gadolinium, silicon and germanium have been found to heat up when magnetized and cool down when removed from a magnetic field. This effect can be large enough to produce a practical cooling effect. Magnetic refrigeration has the potential to produce higher efficiencies than conventional vapour compression cycles without the use of harmful HFCs or CFCs. There are many potential uses for this new technology, but the most promising uses are for refrigeration/freezing and air conditioning. It may also eventually be used in the production of cheap liquid hydrogen as a future fuel source.

Magnetic refrigeration is currently still in the prototype stage with research being conducted by the Ames laboratory and the Astronautics Technology Center. It will take from 5 to 10 years to move magnetic refrigeration to the marketplace, where it will likely find its niche with large supermarket chains, shopping malls and food storage warehouses. Its use in home refrigerators and air conditioners is still 20 years down the road.

The first prototype achieved a cooling power of 600 watts with an impressive COP of 15 using a powerful superconducting magnet. Initial design studies indicate that household magnetic fridge/freezers (which would use less powerful magnets) could have a COP of 3 with a total cooling of 120 watts. Magnetic refrigeration is about 20% more electrically efficient than traditional cooling systems, so although it may initially cost more, consumers would earn back the difference in electricity savings within 5 years.⁵⁹ In practical terms, a typical 18-cu. ft. refrigerator today uses about 680 kWh/yr., and a new magnetic refrigerator may be able to perform at around 540 kWh/yr. Although the initial prototypes and research are focusing on small-appliance type applications, similar savings for commercial fridges and freezers are also possible. In addition, the technology can be extended to air conditioning applications (high-temperature refrigeration) for small commercial packaged equipment.

⁵⁹ ASHRAE Journal, Industry News, *Magnetic Refrigeration*, January 2002.

8.4.2 Thermo-Acoustic Refrigeration

Thermo-acoustic refrigeration employs acoustic power to pump heat. An acoustic driver generates a standing wave that creates a linear temperature gradient within densely packed parallel plates. This temperature gradient is caused by an irreversible heat transfer between the working fluid, which is a noble gas, and the stack plates. The simplicity of thermo-acoustic devices could lead to refrigerators and cooling systems with low manufacturing and maintenance costs and new kinds of air-conditioning systems.

Prototypes have been made, but more research is needed to improve the performance of the heat exchangers used in the system. Research is currently underway at Johns Hopkins University and Purdue University. A home appliance based on thermo-acoustic refrigeration is still years away.

Performance calculations for thermo-acoustic refrigerators predict Coefficients of Performance (COPs) in the order of 40% to 50% of the ideal Carnot cycle, compared with the maximum COP achieved in devices built so far being only 20% of Carnot's cycle. One reason for the discrepancy between the theory and practical devices is the poor performance of the heat exchangers.⁶⁰ This would mean that a typical 18-cu. ft. refrigerator that currently uses 680 kWh/yr. may actually use less than 340 kWh/yr. using this technology. As with magnetic refrigeration, this emerging technology has so far focused on small residential type prototypes. However, the technology can be extended to larger demand equipment used in commercial air conditioning and refrigeration applications.

8.4.3 Linear Compressors

A linear motor/compressor can replace the standard rotating motor/compressor as the prime mover in a conventional Rankine cycle refrigerator. It is compatible with CFC or non-CFC working fluids, requires no lubricant and maintains a higher electrical efficiency than any existing rotating motor/compressor commercially available today.

LG Electronics from Korea announced that it had successfully tested a linear compressor in a 24-cu. ft. commercial refrigerator at the Appliance Manufacturer Conference and Expo 2000. LGE is now testing these refrigerators in the field, initially in Korea but eventually all around the world. Sunpower has also indicated that they could mass-produce linear machines at about the same cost as conventional machines, however more experience with large-scale production will be needed to confirm this claim.

LG Electronics' refrigerator that used a linear compressor reduced electricity consumption by 47% compared to the baseline model with a reciprocating compressor. Much of the electricity savings is realized by virtue of the fact that a linear compressor does not require a crank mechanism to convert rotary motion into reciprocating motion, which can account for up to half the friction loss in a standard system.⁶¹ In practical terms this means around 360 kWh/yr. annual consumption compared to the current 680 kWh/yr.

⁶⁰ www.me.jhu.edu/~htl/research/thermoacoustic/thermoacoustic.htm

⁶¹ www.ammagazine.com

for a typical 18-cu. ft. residential refrigerator. As with the previous refrigeration technologies, this emerging technology has so far focused on small residential type prototypes. However, the technology could be extended to larger demand equipment used in commercial air conditioning and refrigeration applications.

8.4.4 Potential CPR Impacts of Advanced Refrigeration Technologies

The impact of these refrigeration emerging technologies would be modest given that residential refrigeration represent an estimated 9% of the total residential electricity use in the base year.

9. SUMMARY OF FINDINGS

The study findings confirm the existence of significant potential cost-effective electrical efficiency improvements in B.C.'s residential sector. In the "most likely" and "upper" achievable scenarios those electrical efficiency improvements would provide between 1,333 and 2,265 GWh/yr. of electricity savings in FY 2015/16 as well as on-peak demand savings of approximately 241 to 406 MW.

Lighting, followed by kitchen and laundry appliances represent the largest share of the identified savings potential.

Note: As in any study of this type, the results presented in this report are based on a number of important assumptions. Assumptions such as those related to the current penetration of efficient technologies and the rate of future growth in the stock of residential buildings are particularly influential. Wherever possible, the assumptions used in this study are consistent with those used by BC Hydro. However, the reader is referred to a number of caveats throughout the main text of the report.

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11. GLOSSARY OF TERMS

(NOTE: underlined expressions are defined in this glossary.)

achievable potential:

The portion of savings identified in the economic potential that could realistically be achieved within the study period.

avoided cost:

The unit cost of acquiring the next resource to meet demand, which is used as a measure for evaluating individual demand- and supply-side options.

BC Hydro service area:

The portion of the Province of B.C. that receives retail electricity service from BC Hydro. The service region excludes the area served by Aquila Networks Canada (previously known as West Kootenay Power and Utilicorp Networks Canada) and, for the purpose of this study, includes the city of New Westminster. Approximately 75% to 80% of B.C.'s demand for electricity is in the BC Hydro service region and is supplied by BC Hydro.

co-generation:

The simultaneous production of electric or mechanical energy and useful heat energy from a single fuel source; for example, several mills in the B.C. forest sector co-generate electricity and process steam from wood waste for use in a pulping process.

cost of conserved energy (CCE):

The annualized unit energy cost of a DSM measure used to determine its cost effectiveness compared to additional electricity supply (as part of the Total Resource Cost Test). It is calculated as the annualized incremental cost (including annual O&M) of the DSM upgrade measure divided by the annual savings achieved, excluding any administrative or program costs to achieve full use of the technology or measure.

demand impacts:

In the context of the Conservation Potential Review 2002, this term refers to the average load reduction over the 6 a.m. to 10 p.m. period during an average weekday in December and January that is anticipated to result from the various electricity saving technologies, programs or actions presented in the CPR 2002.

demand-side management (DSM):

Actions that modify customer demand for electricity and that can defer the need for new energy and capacity additions.

diversity

A relative measure of the likelihood that a series of connected loads will reach peak demand at the same time. A **high diversity** implies that individual connected loads will reach their peak demand at different times whereas a **low diversity** implies that they will reach peak demand at the same time.

economic efficiency:

Allocation of human and natural resources in a way that results in the greatest net economic benefit, regardless of how benefits and costs are distributed within society.

economic potential:

An estimate of the reduction of electricity consumption, relative to the reference case, that would occur if all electricity-consuming equipment were upgraded to the efficiency level that is cost-effective as calculated using the cost of conserved energy (CCE).

electric capacity:

The maximum electric power that a device or system is capable of producing or transferring. Electric capacity is measured in watts, kilowatts, megawatts etc.

electric energy:

It is the cumulative amount of electricity produced or consumed over a period of time. Electric energy is measured in kilowatt hours or gigawatt hours.

electric power:

The instantaneous rate that electric energy is produced, transmitted or consumed. Electric power is measured in watts, kilowatts, megawatts, etc.

electrical efficiency:

The ratio of the useful energy delivered by a system or end-use to the amount of electric energy supplied to it. This ratio measures how well electric energy is translated into another useful form of energy.

electrical intensity:

The ratio of electric energy consumed per application or end-use; for example, kilowatt hours per square metre of lit office space per day or kilowatt hours per tonne of aluminum produced. All else being equal, electrical intensity increases as electrical efficiency decreases.

electricity conservation:

Activities by electricity users that result in a reduction of the electric energy used to provide electric energy services. Electricity conservation can include a wide variety of behavioural or operational changes that result in energy savings. For the purpose of this study only, energy savings achieved through hard-wired or hardware installations are included.

emerging technologies:

New energy-conserving technologies that are expected to be market-ready in any of the years up to and including 2015. This category includes technologies that could be accelerated into the market during that period through targeted financial or technical support.

end-use:

Recognition of the fact that electric energy is of no value to a user without first being transformed, by a piece of equipment, into a service of economic value. For example, office lighting is an end-use, whereas electricity sold to the office tenant is of no value without the equipment (light fixtures, wiring, etc.) needed to convert the electricity into visible light. End-use is often used interchangeably with energy service.

energy service:

An amenity or service supplied jointly by energy and other components/equipment such as buildings, motors and lights. Examples of energy services include residential space heating, commercial refrigeration, aluminum smelting and public transit. The same energy service can frequently be supplied with different mixes of equipment and energy.

financial incentive:

Certain financial features in the utility's demand-side management programs designed to motivate customer participation. They may include features designed to reduce a customer's net cash outlay, pay-back period or cost of finance to participate.

fuel substitution:

The ability to use a different fuel to produce the same energy service; for example, natural gas can be used for space heating instead of electricity.

gigawatt hour (GWh):

One million kilowatt hours.

independent power producer (IPP):

A privately owned electricity-generating facility that is usually connected to a utility's transmission system to sell electricity.

kilowatt (kW):

One thousand watts; a basic unit of measurement of electric power. The amount of energy transferred at a rate of one kilowatt for one hour is a kilowatt hour.

kilowatt hour (kWh):

The basic unit of measurement of electric energy, one kilowatt hour, represents the power of one thousand watts for a period of one hour. A typical non-electrically heated home in B.C. uses about 10,000 kWh per year.

load:

The amount of electricity required by a device, customer or group of customers as measured by an electricity meter.

load displacement:

The reduction of electricity requirements from existing utility customers through electricity conservation or through customer self-generation.

load factor:

The ratio of the average load supplied during a given period to the maximum load occurring during the same period.

load forecast:

An estimate of expected electricity requirements that have to be met by the electrical system in future years.

load shape:

The variation in electrical load over time, usually hour-by-hour. A load shape can be for the system, a customer or an end-use load over a set period such as a day or a year.

load shifting:

Utility DSM program to move electricity consumption from one period to another, most often from periods of high electricity consumption to periods of low electricity consumption (i.e., from on- to off-peak).

megawatt (MW):

One thousand kilowatts.

natural change in electrical intensity:

The future change in electrical intensity that is expected to occur in the absence of utility demand-side management programs. In developing an estimate of natural change in electrical intensity, it is necessary to make an explicit assumption about the future prices of electricity and competing fuels.

peak demand:

The maximum electric power required by a customer, device or system during a specified period (e.g., day, month, year).

peak clipping:

Utility DSM program used to reduce peak demand, without reducing demand at other times of the day or year.

Power Smart:

BC Hydro's demand-side management initiative, originally launched in 1989. Power Smart includes a full range of DSM programs aimed at BC Hydro's residential, commercial and industrial customers.

rate:

Generically refers to a utility's rate structure. **Average rate** specifically refers here to the overall average revenue per kilowatt hour that the utility receives from a given class of customers (e.g. residential) covered by one or more tariffs.

rate structure:

The formulae used by a utility to calculate charges for the use of electricity. For example, the present BC Hydro rate structure for residential customers consists of a basic monthly charge plus charges for the amount of electric energy used (i.e., cents/kWh). Other BC Hydro rate structures charge for energy at a rate per kilowatt hour that depends on the level of consumption, whereas others may include charges for peak demand.

reference case:

An estimate of the expected level of electricity consumption that would occur over the study period in the absence of any new Power Smart initiatives subsequent to FY 2000/01.

resource planning:

The process of long-term planning of electricity generation and transmission facilities to reliably meet the forecast requirements of BC Hydro's domestic customers. It addresses regional supply requirements and can utilize both supply- and demand-side resources while recognizing economic, environmental and social impacts and risks.

Resource Smart:

The name given to BC Hydro's strategy of improvements to existing power generation and transmission facilities to achieve supply-side efficiency through physical and operational modifications.

sector:

A group of customers having a common type of economic activity. BC Hydro divides its customers into three principal sectors: residential, commercial and industrial. Sectors are often divided into subsectors. For example, "offices" is a subsector of the commercial sector.

self-generation:

Generation of electricity by an industry or commercial enterprise whose principal product is not electricity. Self-generation can either reduce the amount of electricity purchased from the utility or it may be sold to the utility as a supply-side resource.

subsectors:

A classification of customers within a sector by common features. Residential subsectors are by type of home (single-family, duplex, apartment, etc.). Commercial subsectors are generally by type of commercial service (office, retail, warehouse, etc.). Industrial subsectors are by product type (pulp and paper, solid wood products, chemicals, etc.).

tariff:

The rate and the terms and conditions of sale for electric power and energy between utility and customer. It includes the type of service, delivery point(s), limitations of obligations to serve, minimum charges, etc.

technical efficiency:

The efficiency of a system, process or device in achieving a certain purpose, measured in terms of the physical inputs required to produce a given output.

total resource cost:

The total economic cost of acquiring energy resources. For DSM programs, this includes costs incurred by the utility (DSM program administration, taxes and incentives) and by the customer (the cost of the DSM measure net of incentives).

utility cost:

The total financial cost incurred by the utility to acquire energy resources. For DSM, the costs include all utility program costs, including incentive costs.

watt:

The basic unit of measurement of electric power.

APPENDICES



APPENDIX A

- **Base Year UEC, Saturations and Fuel Shares for Vancouver Island and Interior Regions**

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Exhibit A.1
Vancouver Island Region Annual Appliance Energy Use (UEC)

Segment	Vent.	DWH	Cook.	Refrig.	Freezer	Dish.	Washer*	Dryer*	Micro.	Computer	Light	ColorTV	Other
	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001
Single Family/Duplex Dwelling													
Non-Electric Heating	550	3403	780	945	780	101	84	1,042	182	130	1,866	513	2,150
Single Family/Duplex Dwelling - Pre 1976, Electric Heating	50	3403	780	945	780	101	84	1,042	182	130	1,866	513	2,150
Single Family/Duplex Dwelling - Post 1976, Electric Heating	50	3403	780	945	780	101	84	1,042	182	130	1,866	513	2,150
Row -													
Non-Electric Heating	331	2,705	604.5	945	780	78.12	63.24	814	182	130	1,400	513	1,450
Row - Pre 1976													
Electric Heating	41	2,705	604.5	945	780	78.12	63.24	814	182	130	1,400	513	1,450
Row - Post 1976													
Electric Heating	41	2,705	604.5	945	780	78.12	63.24	814	182	130	1,400	513	1,450
Low Rise Apartment Units													
Non-Electric Heating	28	2,107	421	632	378	56	46	585	182	130	700	513	300
Low Rise Apartment - Non-Electric Heating - Whole Building Corridor	4,000										20,000		2,900
Low Rise Apartment Units													
Electric Heating	28	2,107	421	632	378	56	46	585	182	130	700	513	300
Low Rise Apartment - Electric Heating - Whole Building Corridor	4,000										19,000		2,900
High Rise Apartment Units													
Non-Electric Heating	28	2,107	421	632	378	56	46	585	182	130	700	513	300
High Rise Apartment - Non-Electric Heating - Whole Building Corridor	22,900										145,000		37,000
High Rise Apartment Units													
Electric Heating	28	2,107	421	632	378	56	46	585	182	130	700	513	300
High Rise Apartment - Electric Heating - Whole Building Corridor	22,900										156,700		37,000
Mobile													
Non-Electric Heating	233	2,650	591	945	780	76	64	795	182	130	1,020	513	3,000
Mobile													
Electric Heating	38	2,650	591	945	780	76	64	795	182	130	1,020	513	3,000

*As detailed data were not available, electricity use for laundry appliances located in apartment common areas is included in the "other end use."

Exhibit A.2
Vancouver Island Region Saturation (%)

Segment	Vent.	DWH	Cook.	Refrig.	Freezer	Dish.	Washer*	Dryer*	Micro.	Computer	Light.	ColorTV	Other
	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001
Single Family/Duplex Dwelling Non-Electric Heating	100%	100%	100%	126%	76%	80%	92%	88%	96%	108%	100%	203%	100%
Single Family/Duplex Dwelling - Pre 1976, Electric Heating	100%	100%	100%	126%	76%	80%	92%	88%	96%	108%	100%	203%	100%
Single Family/Duplex Dwelling - Post 1976, Electric Heating	100%	100%	100%	126%	76%	80%	92%	88%	96%	108%	100%	203%	100%
Row - Non-Electric Heating	100%	100%	100%	108%	47%	78%	88%	95%	94%	91%	100%	177%	100%
Row - Pre 1976 Electric Heating	100%	100%	100%	108%	47%	78%	88%	95%	94%	91%	100%	177%	100%
Row - Post 1976 Electric Heating	100%	100%	100%	108%	47%	78%	88%	95%	94%	91%	100%	177%	100%
Low Rise Apartment Units Non-Electric Heating	100%	100%	100%	100%	10%	50%	50%	45%	91%	63%	100%	100%	100%
Low Rise Apartment - Non-Electric Heating - Whole Building Corridor	100%	100%	100%	100%	10%	50%	50%	45%	91%	63%	100%	100%	100%
Low Rise Apartment Units Electric Heating	100%	100%	100%	100%	10%	50%	50%	45%	91%	63%	100%	100%	100%
Low Rise Apartment - Electric Heating - Whole Building Corridor	100%	100%	100%	100%	10%	50%	50%	45%	91%	63%	100%	100%	100%
High Rise Apartment Units Non-Electric Heating	100%	100%	100%	100%	15%	50%	50%	45%	91%	63%	100%	127%	100%
High Rise Apartment - Non-Electric Heating - Whole Building Corridor	100%	100%	100%	100%	15%	50%	50%	45%	91%	63%	100%	127%	100%
High Rise Apartment Units Electric Heating	100%	100%	100%	100%	15%	50%	50%	45%	91%	63%	100%	127%	100%
High Rise Apartment - Electric Heating - Whole Building Corridor	100%	100%	100%	100%	15%	50%	50%	45%	91%	63%	100%	127%	100%
Mobile Non-Electric Heating	100%	100%	100%	108%	48%	50%	79%	83%	97%	37%	100%	179%	100%
Mobile Electric Heating	100%	100%	100%	108%	48%	50%	79%	83%	97%	37%	100%	179%	100%

*As detailed data were not available, electricity use for laundry appliances located in apartment common areas is included in the "other end use."
Source: BC Hydro Residential End Use Survey (REUS), July 2001.

Exhibit A.3 Vancouver Island Region Fuel Share (%)

Segment	Space heating	Vent.	DWH	Cook.	Refrig.	Freezer	Dish.	Washer*	Dryer*	Micro.	Computer	Light.	ColorTV	Other
	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001
Single Family/Duplex Dwelling														
Non-Electric Heating	13%	100%	11%	85%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Single Family/Duplex Dwelling - Pre 1976, Electric Heating	70%	100%	61%	85%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Single Family/Duplex Dwelling - Post 1976, Electric Heating	70%	100%	61%	85%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Row - Non-Electric Heating	11%	100%	7%	96%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Row - Pre 1976 Electric Heating	72%	100%	72%	96%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Row - Post 1976 Electric Heating	72%	100%	72%	96%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Low Rise Apartment Units	7%	100%	5%	94%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Low Rise Apartment - Non-Electric Heating	1%	100%										100%		100%
Low Rise Apartment - Whole Building Corridor Heating	100%**	100%	25%	94%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Low Rise Apartment - Electric Heating	5%	100%										100%		100%
Low Rise Apartment - Whole Building Corridor Heating	15%	100%	5%	94%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
High Rise Apartment Units	1%	100%										100%		100%
High Rise Apartment - Non-Electric Heating	100%**	100%	25%	94%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
High Rise Apartment - Electric Heating	5%	100%										100%		100%
High Rise Apartment - Whole Building Corridor Heating	40%	100%	75%	100%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Mobile Non-Electric Heating	80%	100%	100%	100%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Mobile Electric Heating														

*As detailed data were not available, electricity use for laundry appliances located in apartment common areas is included in the "other end use."

** It is recognized that a small share of apartment space heating is from natural gas fireplaces; however, data were not available for further analysis.

Source: BC Hydro Residential End Use Survey (REUS), July 2001.

Exhibit A.4
Vancouver Island Region Average Electricity Use per Dwelling Unit (UEC)

Segment	Space Heating	Vent.	DWH	Cook.	Refrig.	Freezer	Dish.	Washer*	Dryer*	Micro.	Computer	Light.	ColorTV	Other	TOTAL
	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001
Single Family/Duplex Dwelling	1,645	550	374	663	1,191	593	81	77	889	175	140	1,866	1,041	2,150	11,436
Non-Electric Heating															
Single Family/Duplex Dwelling - Pre 1976, Electric Heating	9,256	50	2,076	663	1,191	593	81	77	889	175	140	1,866	1,041	2,150	20,248
Single Family/Duplex Dwelling - Post 1976, Electric Heating	7,459	50	2,076	663	1,191	593	81	77	889	175	140	1,866	1,041	2,150	18,451
Row -															
Non-Electric Heating	757	331	189	580	1,021	367	61	56	750	171	118	1,400	908	1,450	8,158
Row - Pre 1976															
Electric Heating	4,079	41	1,948	580	1,021	367	61	56	750	171	118	1,400	908	1,450	12,949
Row - Post 1976															
Electric Heating	3,312	41	1,948	580	1,021	367	61	56	750	171	118	1,400	908	1,450	12,182
Low Rise Apartment Units															
Non-Electric Heating	200	28	105	396	632	38	28	23	255	166	82	700	513	300	3,466
Low Rise Apartment - Non-Electric Heating - Whole Building Corridor	364	4,000										20,000		2,900	27,264
Low Rise Apartment Units															
Electric Heating	2,800	28	527	396	632	38	28	23	255	166	82	700	513	300	6,487
Low Rise Apartment - Electric Heating - Whole Building Corridor	1,818	4,000										19,000		2,900	27,718
High Rise Apartment Units															
Non-Electric Heating	400	28	105	396	632	57	28	23	255	166	82	700	652	300	3,823
High Rise Apartment - Non-Electric Heating - Whole Building Corridor	3,058	22,900										145,000		37,000	207,958
High Rise Apartment Units															
Electric Heating	2,700	28	527	396	632	57	28	23	255	166	82	700	652	300	6,545
High Rise Apartment - Electric Heating - Whole Building Corridor	10,400	22,900										156,700		37,000	227,000
Mobile															
Non-Electric Heating	2,800	233	1,988	591	1,021	374	38	51	640	177	48	1,020	918	3,000	12,898
Mobile															
Electric Heating	5,600	38	2,650	591	1,021	374	38	51	640	177	48	1,020	918	3,000	16,166

* As detailed data were not available, electricity use for laundry appliances located in apartment common areas is included in the "other end use."

Exhibit A.5 Interior Region Annual Appliance Energy Use (UEC)

Segment	Vent. 2001	DWH 2001	Cook. 2001	Refrig. 2001	Freezer 2001	Dish. 2001	Washer* 2001	Dryer* 2001	Micro. 2001	Computer 2001	Light. 2001	ColorTV 2001	Other 2001
Single Family/Duplex Dwelling Non-Electric Heating	550	2790	640	945	780	83	72	896	182	130	1,530	513	2,150
Single Family/Duplex Dwelling - Pre 1976, Electric Heating	50	2790	640	945	780	83	72	896	182	130	1,530	513	2,150
Single Family/Duplex Dwelling - Post 1976, Electric Heating	50	2790	640	945	780	83	72	896	182	130	1,530	513	2,150
Row - Non-Electric Heating	283	2,331	521.1	945	780	67.5	57.6	720	182	130	1,222	513	1,300
Row - Pre 1976 Electric Heating	41	2,331	521.1	945	780	67.5	57.6	720	182	130	1,222	513	1,300
Row - Post 1976 Electric Heating	41	2,331	521.1	945	780	67.5	57.6	720	182	130	1,222	513	1,300
Low Rise Apartment Units Non-Electric Heating	28	1,854	371	632	378	49	45	557	182	130	625	500	275
Low Rise Apartment - Non-Electric Heating - Whole Building Corridor	3,350										16,500		2,400
Low Rise Apartment Units Electric Heating	28	1,854	371	632	378	49	45	557	182	130	625	500	275
Low Rise Apartment - Electric Heating - Whole Building Corridor	3,200										21,850		4,600
High Rise Apartment Units Non-Electric Heating	28	1,854	371	632	378	49	45	557	182	130	625	513	300
High Rise Apartment - Non-Electric Heating - Whole Building Corridor	20,600										139,700		27,100
High Rise Apartment Units Electric Heating	28	1,854	371	632	378	49	45	557	182	130	625	513	300
High Rise Apartment - Electric Heating - Whole Building Corridor	8,900										60,750		12,900
Mobile Non-Electric Heating	233	2,280	508	945	780	65	66	809	182	130	877	513	3,000
Mobile Electric Heating	38	2,280	508	945	780	65	66	809	182	130	877	513	3,000

*As detailed data were not available, electricity use for laundry appliances located in apartment common areas is included in the "other end use."

Exhibit A.6 Interior Region Saturation (%)

Segment	Vent.	DWH	Cook.	Refrig.	Freezer	Dish.	Washer*	Dryer*	Micro.	Computer	Light.	ColorTV	Other
	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001
Single Family/Duplex Dwelling	100%	100%	100%	123%	86%	72%	91%	92%	98%	92%	100%	178%	100%
Non-Electric Heating	100%	100%	100%	123%	86%	72%	91%	92%	98%	92%	100%	178%	100%
Single Family/Duplex Dwelling - Pre 1976, Electric Heating	100%	100%	100%	123%	86%	72%	91%	92%	98%	92%	100%	178%	100%
Single Family/Duplex Dwelling - Post 1976, Electric Heating	100%	100%	100%	124%	65%	64%	86%	95%	88%	81%	100%	174%	100%
Row - Non-Electric Heating	100%	100%	100%	124%	65%	64%	86%	95%	88%	81%	100%	174%	100%
Row - Pre 1976	100%	100%	100%	124%	65%	64%	86%	95%	88%	81%	100%	174%	100%
Electric Heating	100%	100%	100%	124%	65%	64%	86%	95%	88%	81%	100%	174%	100%
Row - Post 1976	100%	100%	100%	100%	15%	41%	45%	45%	91%	66%	100%	127%	100%
Electric Heating	100%	100%	100%	100%	15%	41%	45%	45%	91%	66%	100%	127%	100%
Low Rise Apartment Units	100%	100%	100%	100%	15%	41%	45%	45%	91%	66%	100%	127%	100%
Non-Electric Heating	100%	100%	100%	100%	15%	41%	45%	45%	91%	66%	100%	127%	100%
Low Rise Apartment - Non-Electric Heating - Whole Building Corridor	100%	100%	100%	100%	15%	41%	45%	45%	91%	66%	100%	127%	100%
Low Rise Apartment Units	100%	100%	100%	100%	15%	41%	45%	45%	91%	66%	100%	127%	100%
Electric Heating	100%	100%	100%	100%	15%	41%	45%	45%	91%	66%	100%	127%	100%
Low Rise Apartment - Electric Heating - Whole Building Corridor	100%	100%	100%	100%	15%	41%	45%	45%	91%	66%	100%	127%	100%
High Rise Apartment Units	100%	100%	100%	100%	15%	41%	45%	45%	91%	66%	100%	127%	100%
Non-Electric Heating	100%	100%	100%	100%	15%	41%	45%	45%	91%	66%	100%	127%	100%
High Rise Apartment - Non-Electric Heating - Whole Building Corridor	100%	100%	100%	100%	15%	41%	45%	45%	91%	66%	100%	127%	100%
High Rise Apartment Units	100%	100%	100%	100%	15%	41%	45%	45%	91%	66%	100%	127%	100%
Electric Heating	100%	100%	100%	100%	15%	41%	45%	45%	91%	66%	100%	127%	100%
High Rise Apartment - Electric Heating - Whole Building Corridor	100%	100%	100%	100%	15%	41%	45%	45%	91%	66%	100%	127%	100%
Mobile	100%	100%	100%	113%	83%	45%	95%	98%	95%	57%	100%	142%	100%
Non-Electric Heating	100%	100%	100%	113%	83%	45%	95%	98%	95%	57%	100%	142%	100%
Mobile	100%	100%	100%	113%	83%	45%	95%	98%	95%	57%	100%	142%	100%
Electric Heating	100%	100%	100%	113%	83%	45%	95%	98%	95%	57%	100%	142%	100%

* As detailed data were not available, electricity use for laundry appliances located in apartment common areas is included in the "other end use."
Source: BC Hydro Residential End Use Survey (REUS), July 2001.

Exhibit A.7 Interior Region Fuel Share (%)

Segment	Space heating 2001	Vent. 2001	DWH 2001	Cook. 2001	Refrig. 2001	Freezer 2001	Dish. 2001	Washer* 2001	Dryer* 2001	Micro. 2001	Computer 2001	Light. 2001	ColorTV 2001	Other 2001
Single Family/Duplex Dwelling Non-Electric Heating	33%	100%	65%	97%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Single Family/Duplex Dwelling - Pre 1976, Electric Heating	80%	100%	88%	97%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Single Family/Duplex Dwelling - Post 1976, Electric Heating	90%	100%	88%	97%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Row - Non-Electric Heating	20%	100%	47%	99%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Row - Pre 1976 Electric Heating	79%	100%	84%	99%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Row - Post 1976 Electric Heating	79%	100%	84%	99%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Low Rise Apartment Units Non-Electric Heating	7%	100%	22%	94%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Low Rise Apartment - Non-Electric Heating - Whole Building Corridor	2%	100%										100%		100%
Low Rise Apartment Units Electric Heating	100%**	100%	51%	94%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Low Rise Apartment - Electric Heating - Whole Building Corridor	10%	100%										100%		100%
High Rise Apartment Units Non-Electric Heating	20%	100%	22%	94%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
High Rise Apartment - Non-Electric Heating - Whole Building Corridor	1%	100%										100%		100%
High Rise Apartment Units Electric Heating	100%**	100%	51%	94%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
High Rise Apartment - Electric Heating - Whole Building Corridor	15%	100%										100%		100%
Mobile Non-Electric Heating	20%	100%	85%	92%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Mobile Electric Heating	65%	100%	100%	92%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%

*As detailed data were not available, electricity use for laundry appliances located in apartment common areas is included in the "other end use."

** It is recognized that a small share of apartment space heating is from natural gas fireplaces; however, data were not available for further analysis.

Source: BC Hydro Residential End Use Survey (REUS), July 2001.

Exhibit A.8 **Interior Region Average Electricity Use per Dwelling Unit (UEC)**

Segment	Space Heating	Vent.	DWH	Cook.	Refrig.	Freezer	Dish.	Washer*	Dryer*	Micro.	Computer	Light.	ColorTV	Other	TOTAL
	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001
Single Family/Duplex Dwelling - Non-Electric Heating	3,645	550	1,814	621	1,162	671	60	66	800	178	120	1,530	913	2,150	14,278
Single Family/Duplex Dwelling - Pre 1976, Electric Heating	9,574	50	2,455	621	1,162	671	60	66	800	178	120	1,530	913	2,150	20,349
Single Family/Duplex Dwelling - Post 1976, Electric Heating	8,796	50	2,455	621	1,162	671	60	66	800	178	120	1,530	913	2,150	19,571
Row - Non-Electric Heating	1,314	283	1,096	516	1,172	507	43	50	663	160	105	1,222	893	1,300	9,324
Row - Pre 1976 Electric Heating	4,403	41	1,958	516	1,172	507	43	50	663	160	105	1,222	893	1,300	13,034
Row - Post 1976 Electric Heating	3,598	41	1,958	516	1,172	507	43	50	663	160	105	1,222	893	1,300	12,229
Low Rise Apartment Units - Non-Electric Heating	193	28	408	349	632	57	20	20	243	166	86	625	635	275	3,736
Low Rise Apartment - Non-Electric Heating - Whole Building Corridor	730	3,350										16,500		2,400	22,980
Low Rise Apartment Units - Electric Heating	2,700	28	946	349	632	57	20	20	243	166	86	625	635	275	6,781
Low Rise Apartment - Electric Heating - Whole Building Corridor	2,700	3,200										21,850		4,600	32,350
High Rise Apartment Units - Non-Electric Heating	540	28	408	349	632	57	20	23	243	166	86	625	652	300	4,127
High Rise Apartment - Non-Electric Heating - Whole Building Corridor	2,490	20,600										139,700		27,100	189,890
High Rise Apartment Units - Electric Heating	2,600	28	946	349	632	57	20	23	243	166	86	625	652	300	6,725
High Rise Apartment - Electric Heating - Whole Building Corridor	12,117	8,900										60,750		12,900	94,667
Mobile - Non-Electric Heating	1,400	233	1,938	467	1,068	647	29	63	769	173	74	877	728	3,000	11,467
Mobile - Electric Heating	4,550	38	2,280	467	1,068	647	29	63	769	173	74	877	728	3,000	14,764

* As detailed data were not available, electricity use for laundry appliances located in apartment common areas is included in the "other end use."

Exhibit A.9
Annual Appliance Energy Use (UEC), 2001 for the Lower Mainland (kWh/Yr)

Segment	Vent.	DWH	Cook.	Refrig.	Freezer	Dish.	Washer*	Dryer*	Micro.	Computer	Light.	ColorTV	Other
	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001
Single Family/Duplex Dwelling													
Non-Electric Heating	550	2790	640	945	780	83	69	860	182	130	1,530	513	2,000
Single Family/Duplex Dwelling - Pre 1976, Electric Heating	50	2790	640	945	780	83	69	860	182	130	1,530	513	2,000
Single Family/Duplex Dwelling - Post 1976, Electric Heating	50	2790	640	945	780	83	69	860	182	130	1,530	513	2,000
Row - Non-Electric Heating	235	2,202	491.92	632	780	63.64	51.6	645	182	130	1,000	513	950
Row - Pre 1976 Electric Heating	41	2,202	491.92	632	780	63.64	51.6	645	182	130	1,000	513	950
Row - Post 1976 Electric Heating	41	2,202	491.92	632	780	63.64	51.6	645	182	130	1,000	513	950
Low Rise Apartment Units	28	2,000	382	632	378	56	46	511	182	130	700	513	300
Non-Electric Heating													
Low Rise Apartment - Non-Electric Heating - Whole Building Corridor	2,600										12,400		1,000
Low Rise Apartment Units	28	2,000	382	632	378	56	46	511	182	130	700	513	300
Electric Heating													
Low Rise Apartment - Electric Heating - Whole Building Corridor	2,600										12,600		1,900
High Rise Apartment Units	28	2,107	382	632	378	56	46	511	182	130	700	513	300
Non-Electric Heating													
High Rise Apartment - Non-Electric Heating - Whole Building Corridor	14,700										72,000		10,700
Electric Heating	28	2,107	382	632	378	56	46	511	182	130	700	513	300
High Rise Apartment - Electric Heating - Whole Building Corridor	18,200										124,400		26,500
Mobile	233	2,270	508	945	780	65	55	680	182	130	877	513	2,000
Non-Electric Heating													
Mobile	38	2,270	508	945	780	65	55	680	182	130	877	513	2,000
Electric Heating													

*As detailed data were not available, electricity use for laundry appliances located in apartment common areas is included in the "other end use."

Exhibit A.10
Appliance Saturation Levels, 2001 (%) Lower Mainland

Segment	Vent.	DWH	Cook.	Refrig.	Freezer	Dish.	Washer*	Dryer*	Micro.	Computer	Light.	ColorTV	Other
	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001
Single Family/Duplex Dwelling Non-Electric Heating	100%	100%	100%	126%	100%	69%	92%	91%	96%	82%	100%	179%	100%
Single Family/Duplex Dwelling - Pre 1976, Electric Heating	100%	100%	100%	126%	100%	69%	92%	91%	96%	82%	100%	179%	100%
Single Family/Duplex Dwelling - Post 1976, Electric Heating	100%	100%	100%	126%	100%	69%	92%	91%	96%	82%	100%	179%	100%
Row - Non-Electric Heating	100%	100%	100%	100%	69%	44%	80%	81%	89%	62%	100%	127%	100%
Row - Pre 1976 Electric Heating	100%	100%	100%	100%	69%	44%	80%	81%	89%	62%	100%	127%	100%
Row - Post 1976 Electric Heating	100%	100%	100%	100%	69%	44%	80%	81%	89%	62%	100%	127%	100%
Low Rise Apartment Units Non-Electric Heating	100%	100%	100%	100%	10%	41%	50%	44%	50%	42%	100%	100%	100%
Low Rise Apartment - Non-Electric Heating - Whole Building Corridor	100%										100%		100%
Low Rise Apartment Units Electric Heating	100%	100%	100%	100%	10%	41%	50%	44%	50%	42%	100%	100%	100%
Low Rise Apartment - Electric Heating - Whole Building Corridor	100%										100%		100%
High Rise Apartment Units Non-Electric Heating	100%	100%	100%	100%	15%	41%	50%	44%	91%	42%	100%	127%	100%
High Rise Apartment - Non-Electric Heating - Whole Building Corridor	100%										100%		100%
High Rise Apartment Units Electric Heating	100%	100%	100%	100%	15%	41%	50%	44%	91%	42%	100%	127%	100%
High Rise Apartment - Electric Heating - Whole Building Corridor	100%										100%		100%
Mobile Non-Electric Heating	100%	100%	100%	102%	16%	40%	79%	90%	96%	61%	100%	177%	100%
Mobile Electric Heating	100%	100%	100%	102%	16%	40%	79%	90%	96%	61%	100%	177%	100%

*As detailed data were not available, electricity use for laundry appliances located in apartment common areas is included in the "other end use."
Source: BC Hydro Residential End Use Survey (REUS), July 2001.

Exhibit A.11
Electricity Fuel Shares (%) Lower Mainland

Segment	Space heating	Vent.	DWH	Cook.	Refrig.	Freezer	Dish.	Washer*	Dryer*	Micro.	Computer	Light.	ColorTV	Other
	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001
Single Family/Duplex Dwelling														
Non-Electric Heating	10%	100%	23%	85%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Single Family/Duplex Dwelling - Pre 1976, Electric Heating	50%	100%	80%	85%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Single Family/Duplex Dwelling - Post 1976, Electric Heating	50%	100%	80%	85%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Row -														
Non-Electric Heating	4%	100%	13%	92%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Row - Pre 1976														
Electric Heating	50%	100%	85%	92%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Row - Post 1976														
Electric Heating	50%	100%	85%	92%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Low Rise Apartment Units														
Non-Electric Heating	20%	100%	3%	99%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Low Rise Apartment - Non-Electric Heating - Whole Building Corridor	1%	100%												100%
Low Rise Apartment Units														
Electric Heating	100%**	100%	48%	99%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Low Rise Apartment - Electric Heating - Whole Building Corridor	5%	100%												100%
High Rise Apartment Units														
Non-Electric Heating	20%	100%	3%	99%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
High Rise Apartment - Non-Electric Heating - Whole Building Corridor	1%	100%												100%
High Rise Apartment Units														
Electric Heating	100%**	100%	48%	99%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
High Rise Apartment - Electric Heating - Whole Building Corridor	5%	100%												100%
Mobile														
Non-Electric Heating	14%	100%	71%	92%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%
Mobile														
Electric Heating	45%	100%	62%	92%	100%	100%	100%	100%	97%	100%	100%	100%	100%	100%

As detailed data were not available, electricity use for laundry appliances located in apartment common areas is included in the "other" end use.
 ** It is recognized that a small share of apartment space heating is from natural gas fireplaces; however, data were not available for further analysis.
 Source: BC Hydro Residential End Use Survey (REUS), July 2001.

Exhibit A.12
Average Electricity Use per Dwelling Unit (kWh/Yr) Lower Mainland

Segment	Space Heating	Vent.	DWH	Cook.	Refrig.	Freezer	Dish.	Washer*	Dryer*	Micro.	Computer	Light.	ColorTV	Other	TOTAL
	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001	2001
Single Family/Duplex Dwelling	1,350	550	642	544	1,191	780	57	63	759	175	107	1,530	918	2,000	10,666
Non-Electric Heating															
Single Family/Duplex Dwelling - Pre 1976, Electric Heating	7,223	50	2,232	544	1,191	780	57	63	759	175	107	1,530	918	2,000	17,629
Single Family/Duplex Dwelling - Post 1976, Electric Heating	6,110	50	2,232	544	1,191	780	57	63	759	175	107	1,530	918	2,000	16,516
Row - Non-Electric Heating	288	235	286	453	632	538	28	41	507	162	81	1,000	652	950	5,852
Row - Pre 1976 Electric Heating	3,125	41	1,871	453	632	538	28	41	507	162	81	1,000	652	950	10,080
Row - Post 1976 Electric Heating	2,768	41	1,971	453	632	538	28	41	507	162	81	1,000	652	950	9,723
Low Rise Apartment Units	600	28	60	378	632	38	23	23	218	91	55	700	513	300	3,659
Non-Electric Heating															
Low Rise Apartment - Non-Electric Heating - Whole Building Corridor	236	2,600										12,400		1,000	16,236
Low Rise Apartment Units	3,000	28	960	378	632	38	23	23	218	91	55	700	513	300	6,959
Electric Heating															
Low Rise Apartment - Electric Heating - Whole Building Corridor	1,180	2,600										12,600		1,900	18,280
High Rise Apartment Units	550	28	63	378	632	57	23	23	218	166	55	700	652	300	3,844
Non-Electric Heating															
High Rise Apartment - Non-Electric Heating - Whole Building Corridor	1,336	14,700										72,000		10,700	98,736
High Rise Apartment Units	2,750	28	1,011	378	632	57	23	23	218	166	55	700	652	300	6,992
Electric Heating															
High Rise Apartment - Electric Heating - Whole Building Corridor	8,270	18,200										124,400		26,500	177,370
Mobile	1,184	233	1,612	467	964	125	26	43	594	175	79	877	908	2,000	9,287
Non-Electric Heating															
Mobile	3,807	38	1,407	467	964	125	26	43	594	175	79	877	908	2,000	11,510
Electric Heating															

* As detailed data were not available, electricity use for laundry appliances located in apartment common areas is included in the "other end use."

APPENDIX B

- **Detailed Technology Cost and Performance Data**

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Exhibit B.22	Window Upgrade – Existing Buildings
Exhibit B.23	Television
Exhibit B.24	Flat Screen Monitor
Exhibit B.25	Energy Star compliant Computer
Exhibit B.26	Consumer Electronics – Reduced Standby Losses

Exhibit B.1
Energy Efficiency Upgrades
Cost and Performance Data
- Freezer -

Type	Technology	Annual Consumption kWh/yr	Energy Svngs 1 kWh/year	Energy Svngs 2 kWh/year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (\$/kWh)										
					Capital	Installation	Full	Incremental			D.R. =		6.00%		8.00%		10.00%				
											Full	Incr.	Full	Incr.	Full	Incr.	Full	Incr.			
Single Family/Duplex/row/mobile	Existing Baseline	400				\$850		\$850	\$0.00	20											
	Upgrade 1	330	70	75		\$1,000	\$0	\$1,000	\$150	20			17.5			20.4				23.5	
	Alternate 1	320	80	86		\$850	\$0	\$850	\$0	20			0.0			0.0				0.0	
Apartment Suite	Existing Baseline	350				\$599	\$0	\$599	\$0.00	20											
	Upgrade 1	300	50	54		\$700	\$0	\$700	\$101	20			16.5			19.2				22.2	
	Alternate 1	280	70	75		\$599	\$0	\$599	\$0	20			0.0			0.0				0.0	

Notes:

CCEs are based on Energy Savings 2, which include line losses.

Value used:

7%

Line Losses

Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.

Typical new appliance cost and energy obtained from published data

Cost and performance obtained from in-store survey

Prices listed are based on current list price. Prices vary in the marketplace. The incremental cost for the upgrade is the key variable used in calculating the CCE.

Exhibit B.2
Energy Efficiency Upgrades
Cost and Performance Data
- Refrigeration

Type	Technology	Annual Consumption kWh/Year	Energy Savings 1 kWh/Year	Energy Savings 2 kWh/Year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (\$/kWh)					
					Capital	Installation	Full	Incremental			D.R. = Full	6.00% Incr.	D.R. = Full	6.00% Incr.	D.R. = Full	10.00% Incr.
Single Family/Duplex/Row/Mobile	Existing Baseline	640			\$1,000	\$0	\$1,000		\$0.00	20						
	Upgrade 1 Energy Star refrigerator	417	223	239	\$1,100	\$0	\$1,100	\$100	\$0.00	20		3.7		4.3		4.9
Upgrade 2 Sunfrost		281	359	384	\$4,000	\$0	\$4,000	\$3,000	\$0.00	20		68.1		79.5		91.7
Apartment Suite	Existing Baseline	440			\$750	\$0	\$750		\$0.00	20						
	Upgrade 1 Energy Star refrigerator	372	68	73	\$750	\$0	\$750	\$0	\$0.00	20		0.0		0.0		0.0

Notes:
 CCEs are based on Energy Savings 2, which include line losses.
 Value used: 7%
 Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.
 Typical new appliance cost and energy obtained from published data
 Cost and performance obtained from in-store survey

Prices listed are based on current list price. Prices vary in the marketplace. The incremental cost for the upgrade is the key variable used in calculating the CCE.

Exhibit B.3
Energy Efficiency Upgrades
Cost and Performance Data
- Dishwasher, Elect DHW

Type	Technology	Annual Consumption kWh/year	Energy Svngs 1 kWh/year	Energy Svngs 2 kWh/year	Technology Costs		Installed Costs	Incr. Ann. O&M	Life (yrs)	CCEs (¢/kWh)			
					Capital	Installation	Full			D.R. = Full	D.R. = Full	D.R. = Full	D.R. = Full
Existing Baseline	new conventional	688	162	173	\$650	\$0	\$650	\$0.00	14	15.5	0.0	0.0	0.0
Upgrade 1	New Energy Star dishwasher	526	307	328	\$650	\$0	\$650	\$0.00	14	15.5	0.0	0.0	0.0
Upgrade 2	High efficiency dishwasher	381			\$1,122	\$0	\$1,122	\$472	14	15.5	17.4	17.4	19.5

Notes:

CCEs are based on Energy Savings 2, which include line losses.

Value used:

7%

Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.

Typical new appliance cost and energy obtained from published data

Cost and performance obtained from in-store survey

Prices listed are based on current list price. Prices vary in the marketplace. The incremental cost for the upgrade is the key variable used in calculating the CCE.

Exhibit B.4

Type	Technology	Annual Consumption kWh/year	Energy Svgs 1 kWh/year	Energy Svgs 2 kWh/year	Technology Costs	Installed Costs	Inc'r Ann. O&M	Life (yrs)	DR = 6.00%	DR = 8.00%	CCEs (\$/kWh)
					Capital	Full			Full	Incr.	
Existing Baseline	New Top Load Washing Machine	797	453	492	\$0	\$1,200	\$0.00	14	Full	Incr.	10.00%
Upgrade 1	Energy Star top-loading clothes washer	337	503	492	\$0	\$1,399	\$0.00	14	Full	Incr.	5.5
Upgrade 2	Horizontal axis clothes washer	294	460	538	\$0	\$1,750	\$0.00	14	Full	Incr.	13.9

Notes:
CCEs
Line Losses

Value used.

Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the value used.

Typical new appliance cost and energy obtained from published data

Cost and performance obtained from in-store survey

Prices listed are based on current list price. Prices vary in the marketplace. The incremental cost for the upgrade is the key variable used in calculating the CCE.

Exhibit B.5
Energy Efficiency Upgrades
Cost and Performance Data
- Microwave/Convection Oven

Type	Technology	Annual Consumption kWh/year	Energy Svgs 1 kWh/year	Energy Svgs 2 kWh/year	Technology Costs		Installed Costs		Incr Ann. O&M	Life (yrs)	CCEs (\$/kWh)			
					Capital	Installation	Full	Incremental			D.R =	6.00%	Full	Incr.
Existing Baseline	Conventional Stove and microwave oven	940			\$0	\$0	\$0		\$0.00	10				
Upgrade 1	Stove + Microwave-Convection Oven	750	190	203	\$1,400	\$0	\$1,400	\$1,400	\$0.00	10		93.6		112.1

Notes:

CCEs are based on Energy Savings 2, which include line losses.

CCEs Value used: 7%

Line Losses

Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options.

Typical new appliance cost and energy obtained from published data

Cost and performance obtained from in-store survey

Baseline

Upgrade

Baseline

Upgrade 1

The microwave convection oven is capable of cooking like a standard oven while using 50% less energy. The savings are based on half of the stove consumption devoted to the oven. This is equivalent to 190 kWh/year savings

Incremental cost is estimated to be approximately \$1400 over the cost of a conventional microwave oven.

Prices listed are based on current list price. Prices vary in the marketplace. The incremental cost for the upgrade is the key variable used in calculating the CCE.

Exhibit B.6
Energy Efficiency Upgrades
Cost and Performance Data
- Furnace Fan Motor - Existing Dwellings

Type	Technology	Annual Consumption kWh/year	Energy Svngs 1 kWh/year	Energy Svngs 2 kWh/year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (\$/kWh)					
					Capital	Installation	Full	Incremental			D.R. = Full	6.00% Incr.	D.R. = Full	8.00% Incr.	D.R. = Full	10.00% Incr.
Single Family/Duplex																
Existing Baseline	Baseline PSC	550			\$85	\$0	\$85		\$0.00	20						
Upgrade 1	ECPM	325	226	241	\$225	\$0	\$225	\$140	\$0.00	20		5.1		5.9		6.8
Row																
Existing Baseline	Baseline PSC	331			\$85	\$0	\$85		\$0.00	20						
Upgrade 1	ECPM	195	136	145	\$225	\$0	\$225	\$140	\$0.00	20		8.4		9.8		11.3
Mobile																
Existing Baseline	Baseline PSC	233			\$85	\$0	\$85		\$0.00	20						
Upgrade 1	ECPM	137	96	102	\$225	\$0	\$225	\$140	\$0.00	20		11.9		14.0		16.1
Single Family/Duplex																
Existing Baseline	Baseline PSC, continuous vent	2,780			\$85	\$0	\$85		\$0.00	20						
Upgrade 1	ECPM continuous vent	608	2,172	2,324	\$225	\$0	\$225	\$140	\$0.00	20		0.5		0.6		0.7

Notes:

CCEs are based on Energy Savings 2, which include line losses.

Line Losses

Value used: 7%

Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.

The baseline furnace fan is assumed to be a one-third HP motor.

The assumed hours of operation are as follows:

Single Family Duplex 1000 hrs/year

Row housing 700 hrs/year

Mobile home 600 hrs.

Cost and performance obtained from ACEEE and NRCAN (see reference section), including forthcoming NRCAN report, "Market Analysis: Energy Savings from Residential Air Handling Equipment."

Exhibit B.7
Energy Efficiency Upgrades
Cost and Performance Data
- Furnace Fan Motor - New Dwellings, Conventional Heating System

Type	Technology	Annual Consumption kWh/year	Energy Svngs 1 kWh/year	Energy Svngs 2 kWh/year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (¢/kWh)												
					Capital	Installation	Full	Incremental			D.R. = 6.00%		D.R. = 8.00%		D.R. = 10.00%								
											Full	Incr.	Full	Incr.	Full	Incr.	Full	Incr.					
Single Family/Duplex																							
Existing Baseline	Baseline PSC	656			\$85	\$0	\$85		\$0.00	20													
Upgrade 1	ECPM	387	269	288	\$225	\$0	\$225	\$140	\$0.00	20													
Row																							
Existing Baseline	Baseline PSC	465			\$85	\$0	\$85		\$0.00	20													
Upgrade 1	ECPM	274	191	204	\$225	\$0	\$225	\$140	\$0.00	20													
Mobile																							
Existing Baseline	Baseline PSC	370			\$85	\$0	\$85		\$0.00	20													
Upgrade 1	ECPM	218	152	162	\$225	\$0	\$225	\$140	\$0.00	20													
Existing Baseline	Baseline PSC, continuous vent	2,780			\$85	\$0	\$85		\$0.00	20													
Upgrade 1	ECPM continuous vent	608	2,172	2,172	\$225	\$0	\$225	\$140	\$0.00	20													

Notes:
CCEs
Line Losses

CCEs are based on Energy Savings 2, which include line losses.
 Value used:
 7%

Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.

The baseline new furnace fan for single detached and row housing is assumed to be a one-third HP motor.

Baseline

The baseline new furnace fan for mobile homes is assumed to be one-third HP motor.

The assumed hours of operation are as follows:

Single Family Duplex 1200 hrs/year

Row housing 900 hrs/year

Mobile home 600 hrs.

Upgrade

Cost and performance obtained from ACEEE and NRCAN (see reference section), including forthcoming NRCAN report, "Market Analysis: Energy Savings from Residential Air Handling Equipment."

Exhibit B.8
Energy Efficiency Upgrades
Cost and Performance Data
- Setback Thermostat - New & Existing Dwellings

Type	Technology	Annual Consumption kWh/year	Energy Svngs 1 kWh/year	Energy Svngs 2 kWh/year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (¢/kWh)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
					Capital	Installation	Full	Incremental			D.R. =		6.00%		8.00%		10.00%																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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Notes:
 CCEs are based on Energy Savings 2, which include line losses.
 Value used: 7%
 Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.
 Obtained from HOT 2000 runs
 Performance obtained from Energy Star website. Cost obtained from in-store survey

Exhibit B.9
Energy Efficiency Upgrades
Cost and Performance Data
- Incandescent Lighting - New and Existing Buildings

Type	Technology	Connected Load W/fixture	Hours of Operation hrs/year	Annual Consumption kWh/fixture	Energy Savings 1 kWh/year	Energy Savings 2 kWh/year	Technology Costs		Installed Costs		Life (yrs)	CCEs (\$/kWh)		
							Capital	Installation	Full	Incremental		D.R. = 6.00%	D.R. = 8.00%	D.R. = 10.00%
Existing Baseline	Baseline: Incandescent	60	1200	72			\$1	\$0	\$1		0.73	Full	Full	Full
Upgrade 1	Replace incandescent with CFL	15	1200	18	54	58	\$11	\$0	\$11	\$10	5.5	Full	Full	Full
Upgrade 2	Replace incandescent with LED	40	1200	48	24	26	\$46	\$0	\$46	\$45	10	Full	Full	Full

Notes:

CCEs are based on Energy Savings 2, which include line losses.

CCEs

Line Losses

Value used: 7%

Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.

Consumption of 60W/fixture for standard incandescent lighting system is based on typical installation. Expect life of bulb estimated at 800 hrs (range is 600 to 1000)

Replace incandescent bulbs with 15 W/fixture CFL. Assume life of CFL at 6000 hr.

Replace incandescent bulbs with 40W LED luminous strip based on an efficacy of 20 Lumens/Watt.

Assume life of LED at 10,000 hr (ref ACEEE).

Exhibit B.10
Energy Efficiency Upgrades
Cost and Performance Data
- Fluorescent Lighting - New & Existing Buildings

Detached	Type	Technology	Connected Load W/ft ²	Hours of Operation hrs/year	Annual Consumption kWh/ft ² -yr	Energy Sngs 1 kWh/year	Energy Sngs 2 kWh/year	Technology Costs		Incr. Ann. O&M	Life (yrs)	CCEs (\$/kWh)					
								Capital \$/fixture	Installation \$/fixture			D.R. = 6.00%		D.R. = 8.00%		D.R. = 10.00%	
												Full	Incr.	Full	Incr.	Full	Incr.
	Existing Baseline	T12 lamp ES, magnetic ballast 42 W/fixture and operation of 1200 hrs/year	42	1200	50			\$0	\$0	\$0.00	20						
	Upgrade 1	Relamp and reballast with T8 lamp and electronic ballast (34 W/fixture)	34.0	1200	41	10	11	\$25.90	\$0.00	\$0.00	20	20.9		24.5		28.2	
Apartment Apartment corridor (per sq foot)																	
	Existing Baseline	T12 lamp ES, magnetic ballast 1.3 W/ft ² and 8760hrs	1.3	8760	11			\$0	\$0	\$0.00	20						
	Upgrade 1	Relamp and reballast with T8 lamps and electronic ballasts	1.0	8760	9	3	3	\$1.15	\$0.43	\$1.58	20	4.7		5.5		6.3	

Notes:
 CCEs are based on Energy Savings 2, which include line losses.
 Value used: 7%
 Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.
 Additional cooling energy savings equal to 5% of the electrical lighting energy savings have been added.
 Consumption of 34W/fixture for standard T8 lighting system is based on Standard SYLVANIA Electronic T8 System Quicktronic 32IS (QT2X32/120S). This is based on F32T8 800 lamps with an Instant Start ballast, ballast factor 0.9.
 Material costs are based on \$21.50 for the ballast and \$4.40 for two lamps.

Exhibit B.11
Energy Efficiency Upgrades
Cost and Performance Data
Holiday Lights - New and Existing Buildings

Holiday Lights - New and Existing Buildings																	
Type	Technology	Connected Load W/string	Hours of Operation hrs/year	Annual Consumption kWh/string	Energy Svngs 1 kWh/year	Energy Svngs 2 kWh/year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (\$/kWh)				
							Capital	Installation	Full	Incremental			D.R. =	6.00%	D.R. =	8.00%	D.R. =
Single Family/Duplex Existing Baseline	Baseline: Incandescent	120	175	21			\$8	\$0	\$8		\$0.00	4.7					
	Upgrade 1 LED	0.4	175	0.1	21	22	\$16	\$0	\$16	\$9	\$0.00	20	6.2	-2.2	7.3	-1.6	8.4

Notes:
 CCEs are based on Energy Savings 2, which include line losses.
 CCEs
 Line Losses Value used: 7%
 Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.
 Baseline BC Hydro
 Upgrade BC Hydro

Exhibit B.12
Energy Efficiency Upgrades
Cost and Performance Data
- Electric Hot Water Heating, Existing Homes, Before DHW Load Reductions

Type	Technology	Annual Consumption kWh/year	Energy Svngs 1 kWh/year	Energy Svngs 2 kWh/year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (\$/kWh)						
					Capital	Installation	Full	Incremental			DR = 6.00%		DR = 8.00%		DR = 10.00%		
Single Family/Duplex	Existing Baseline																
	Upgrade 1	Baseline:	3,403			\$350	\$350	\$700		10							
		baseline + heat trap	3,336	67	71	\$10	\$60	\$70	\$10	\$0.00	10	13.3	1.9	14.6	2.1	16.0	2.3
	upgrade 2	upgrade 1 + heat pump	1,599	1,804	1,930	\$1,600	\$350	\$1,950	\$1,250	\$0.00	10	13.7	8.8	15.1	9.7	16.4	10.5
Row																	
Existing Baseline	Baseline:	2,705				\$350	\$350	\$700		10							
Upgrade 1	heat trap	2,652	53	57	\$10	\$60	\$70	\$10	\$0.00	10	16.8	2.4	18.4	2.6	20.1	2.9	
upgrade 2	upgrade 1 + heat pump	1,271	1,434	1,534	\$1,600	\$350	\$1,950	\$1,250	\$0.00	10	17.3	11.1	18.9	12.1	20.7	13.3	
Apartment Suite																	
Existing Baseline	Baseline:	2,107				\$350	\$350	\$700		10							
Upgrade 1	heat trap	2,066	41	44	\$10	\$60	\$70	\$10	\$0.00	10	21.5	3.1	23.6	3.4	25.8	3.7	
upgrade 2	upgrade 1 + heat pump	990	1,117	1,195	\$1,600	\$350	\$1,950	\$1,250	\$0.00	10	22.2	14.2	24.3	15.6	26.6	17.0	
Mobile																	
Existing Baseline	Baseline:	2,650				\$350	\$350	\$700		10							
Upgrade 1	heat trap	2,598	52	56	\$10	\$60	\$70	\$10	\$0.00	10	17.1	2.4	18.8	2.7	20.5	2.9	
upgrade 2	upgrade 1 + heat pump	1,246	1,405	1,503	\$1,600	\$350	\$1,950	\$1,250	\$0.00	10	17.6	11.3	19.3	12.4	21.1	13.5	

Notes:
 CCEs are based on Energy Savings 2, which include line losses.
 Value used: 7%
 Line Losses
 Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.
 Hot 2000 runs
 Energy impact obtained from LBL report (see reference section).
 Cost data obtained from BC Hydro.

Exhibit B.13
Energy Efficiency Upgrades
Cost and Performance Data
- Electric Hot Water Heating, Existing Homes, After DHW Load Reductions

Type	Technology	Annual Consumption kWh/year	Energy Svngs 1 kWh/year	Energy Svngs 2 kWh/year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (\$/kWh)					
					Capital	Installation	Full	Incremental			6.00%		8.00%		10.00%	
Single Family/Duplex	Existing Baseline:	2,444			\$350	\$350	\$700		\$0.00	10						
	Upgrade 1	2,396	48	51	\$10	\$60	\$70	\$10	\$0.00	10	18.5	2.6	20.3	2.9	22.2	3.2
	upgrade 2	1,149	1,295	1,386	\$1,600	\$350	\$1,950	\$1,250	\$0.00	10	19.1	12.3	21.0	13.4	22.9	14.7
	Row															
Existing Baseline:		1,946			\$350	\$350	\$700		\$0.00	10						
Upgrade 1	heat trap	1,908	38	41	\$10	\$60	\$70	\$10	\$0.00	10	23.3	3.3	25.6	3.7	27.9	4.0
upgrade 2	upgrade 1 + heat pump	915	1,031	1,104	\$1,600	\$350	\$1,950	\$1,250	\$0.00	10	24.0	15.4	26.3	16.9	28.8	18.4
Apartment Suite																
Existing Baseline:		1,610			\$350	\$350	\$700		\$0.00	10						
Upgrade 1	heat trap	1,578	32	34	\$10	\$60	\$70	\$10	\$0.00	10	28.2	4.0	30.9	4.4	33.7	4.8
upgrade 2	upgrade 1 + heat pump	757	853	913	\$1,600	\$350	\$1,950	\$1,250	\$0.00	10	29.0	18.6	31.8	20.4	34.8	22.3
Mobile																
Existing Baseline:		2,026			\$350	\$350	\$700		\$0.00	10						
Upgrade 1	heat trap	1,986	40	43	\$10	\$60	\$70	\$10	\$0.00	10	22.4	3.2	24.5	3.5	26.8	3.8
upgrade 2	upgrade 1 + heat pump	952	1,074	1,149	\$1,600	\$350	\$1,950	\$1,250	\$0.00	10	23.1	14.8	25.3	16.2	27.6	17.7

Notes:
 CCEs are based on Energy Savings 2, which include line losses.
 Value used: 7%
 Line Losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.
 Hot 2000 runs
 Energy impact obtained from LBL report (see reference section).
 Cost data obtained from BC Hydro.

Exhibit B.14
Energy Efficiency Upgrades
Cost and Performance Data
- Electric Hot Water Heating, New Homes, Before DHW Load Reductions

Type	Technology	Annual Consumption kWh/year	Energy Svgs 1 kWh/year	Energy Svgs 2 kWh/year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (\$/kWh)					
					Capital	Installation	Full	Incremental			6.00%		8.00%		10.00%	
Single Family/Duplex	Existing Baseline:	2,647			\$350	\$350	\$700		\$0.00	10						
	Upgrade 1 baseline + heat trap	2,595	52	56	\$10	\$60	\$70	\$10	\$0.00	10						
	upgrade 2	1,244	1,403	1,501	\$1,600	\$350	\$1,950	\$1,250	\$0.00	10						
	Row															
apartment Suite	Existing Baseline:	2,309			\$350	\$350	\$700		\$0.00	10						
	Upgrade 1 heat trap	2,264	45	48	\$10	\$60	\$70	\$10	\$0.00	10						
	upgrade 2	1,085	1,224	1,309	\$1,600	\$350	\$1,950	\$1,250	\$0.00	10						
	Row															
Mobile	Existing Baseline:	1,475			\$350	\$350	\$700		\$0.00	10						
	Upgrade 1 heat trap	1,446	29	31	\$10	\$60	\$70	\$10	\$0.00	10						
	upgrade 2	693	782	836	\$1,600	\$350	\$1,950	\$1,250	\$0.00	10						
	Row															
Mobile	Existing Baseline:	2,000			\$350	\$350	\$700		\$0.00	10						
	Upgrade 1 heat trap	1,961	39	42	\$10	\$60	\$70	\$10	\$0.00	10						
	upgrade 2	940	1,060	1,134	\$1,600	\$350	\$1,950	\$1,250	\$0.00	10						
	Row															

Notes:
 CCEs are based on Energy Savings 2, which include line losses.
 Value used: 7%
 Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, built transmission losses are omitted. Further detail is provided in Section 4 of the main report.
 Hot 2000 runs
 Energy impact obtained from LBL report (see reference section).
 Cost data obtained from BC Hydro.

Exhibit B.15
Energy Efficiency Upgrades
Cost and Performance Data
- Electric Hot Water Heating, New Homes, After DHW Load Reductions

Type	Technology	Annual Consumption kWh/year	Energy Svgs 1 kWh/year	Energy Svgs 2 kWh/year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (\$/kWh)					
					Capital	Installation	Full	Incremental			D.R. = 6.00%		D.R. = 8.00%		D.R. = 10.00%	
Single Family/Duplex	Existing Baseline:	2,124			\$350	\$350	\$700		\$0.00	10						
	Upgrade 1 baseline + heat trap	2,082	42	45	\$10	\$60	\$70	\$10	\$0.00	10						
	Upgrade 2	998	1,126	1,205	\$1,600	\$350	\$1,950	\$1,250	\$0.00	10						
	Flow															
Apartment Suite	Existing Baseline:	1,913			\$350	\$350	\$700		\$0.00	10						
	Upgrade 1 heat trap	1,875	38	40	\$10	\$60	\$70	\$10	\$0.00	10						
	Upgrade 2	899	1,014	1,085	\$1,600	\$350	\$1,950	\$1,250	\$0.00	10						
	Flow															
Mobile	Existing Baseline:	1,194			\$350	\$350	\$700		\$0.00	10						
	Upgrade 1 heat trap	1,171	23	25	\$10	\$60	\$70	\$10	\$0.00	10						
	Upgrade 2	561	633	677	\$1,600	\$350	\$1,950	\$1,250	\$0.00	10						
	Flow															
Mobile	Existing Baseline:	1,728			\$350	\$350	\$700		\$0.00	10						
	Upgrade 1 heat trap	1,692	34	36	\$10	\$60	\$70	\$10	\$0.00	10						
	Upgrade 2	811	915	979	\$1,600	\$350	\$1,950	\$1,250	\$0.00	10						
	Flow															

Notes:
 CCEs are based on Energy Savings 2, which include line losses.
 Value used: 7%
 Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.
 Hot 2000 runs
 Energy impact obtained from LBL report (see reference section).
 Cost data obtained from BC Hydro.

Exhibit B.16
Energy Efficiency Upgrades
Cost and Performance Data
- DHW Tank Insulation

Type	Technology	Annual Cons kWh/year	Energy Svgs 1 kWh/year	Energy Svgs 2 kWh/year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (\$/kWh)					
					Capital	Installation	Full	Incremental			D.R. = Full	Incr.	D.R. = Full	Incr.	D.R. = Full	Incr.
Single Family/Duplex Existing Baseline	40 gal tank	500			\$0	\$0	\$0		\$0.00	10						
	40 gal tank w more insul.	385	115	123	\$37	\$0	\$37	\$37	\$0.00	10	4.1	4.1	4.5	4.5	4.9	4.9
Row Existing Baseline	40 gal tank	667			\$0	\$0	\$0		\$0.00	10						
	40 gal tank w more insul.	513	154	165	\$37	\$0	\$37	\$37	\$0.00	10	3.1	3.1	3.3	3.3	3.7	3.7
Mobile Existing Baseline	40 gal tank	541			\$0	\$0	\$0		\$0.00	10						
	40 gal tank w more insul.	416	125	134	\$37	\$0	\$37	\$37	\$0.00	10	3.8	3.8	4.1	4.1	4.5	4.5

Notes:
 CCEs are based on Energy Savings 2, which include line losses.
 Value used: 7%
 Line Losses
 Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options,
 bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.

Exhibit B.17
Energy Efficiency Upgrades
Cost and Performance Data
- DHW Low Flow Shower Head/Faucet Aerator -

Type	Technology	Annual Cons kWh/year	Energy Svngs 1 kWh/yr	Energy Svngs 2 kWh/yr	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (\$/kWh)					
					Capital \$/appl	Installation \$/appl	Full	Incremental			D.R = Full	D.R = Incr.	D.R = Full	D.R = Incr.	D.R = Full	D.R = Incr.
Upgrade 1	Low Flow Shower Heads/Faucet Aerators	1,406	562	602	\$20.0	\$0.0	\$20.0	\$0	\$0.00	10	0.5		0.5		0.5	

Notes:
 CCEs are based on Energy Savings 2, which include line losses.
 Line Losses Value used: 7%
 Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.
 Upgrade 1 The energy use represents the annual hot water energy consumption for personal use for a single family home
 Note this is mandated in new construction by the BC building code

Exhibit B-18
Energy Efficiency Upgrades
Cost and Performance Data
- Building Envelope

Type	Technology	Annual Consumption kWh/yr	Energy Savings 1 kWh/year	Energy Savings 2 kWh/year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (\$/kWh)			
					Capital \$/ft²	Installation \$/ft²	Full \$/ft²	Incremental \$/ft²			D.R. = Full	Incr.	D.R. = Full	Incr.
Single Family/Duplex	Existing Baseline	2.20								15				
	Upgrade 1	1.10	1.1	1.2	\$1.0	\$0.0	\$1.0		\$0.00	15				
	baseline									15				
	Upgrade 1		13.5	14.4			\$0.7	\$0.7	\$0.00	25		0.4		0.6
Air seal Baseline	Baseline								\$0.00	25				
	Upgrade 1		1,302	1,393.1	\$0.15	\$0	\$0.15	\$0.15	\$0.00	25	4.6	4.6	5.5	6.4

Notes:

CCEs

Line Losses

Value used:

7%

CCEs are based on Energy Savings 2, which include line losses.

Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options,

bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.

Note current code requirement for elec SH homes is R20 walls

Energy impact from Hol 2000 runs. Cost from installation contractors

Exhibit B.19
Energy Efficiency Upgrades
Cost and Performance Data
- Advanced Mechanical Systems-Existing Dwellings

Type	Technology	Annual Consumption kWh/yr	Energy Svgs 1 kWh/yr	Energy Svgs 2 kWh/yr	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (\$/kWh)					
											D.R = 8.00%		D.R = 8.00%		D.R = 10.00%	
					Capital	Installation	Full	Incremental			Full	Incr.	Full	Incr.	Full	Incr.
Detached Existing Baseline	Interior - Pre 1976, Elec baseboard	14,446			\$950	\$950	\$1,900		\$0.00	15						
Upgrade 1	Air Source Heat Pump	9,963	4,483	4,797	\$3,775	\$1,050	\$4,825	\$2,925	\$0.00	15	10.4		11.8		13.2	
Upgrade 2	Advanced Cold Climate Heat Pump COP of 2.8 at 17 F.	5,778	8,668	9,274	\$4,775	\$1,050	\$5,825	\$3,925	\$0.00	15	6.5		7.3		8.3	
Upgrade 3	Ground Source Heat Pump	5,350	9,096	9,732	\$19,750	\$6,750	\$26,500	\$24,600	\$0.00	15	28.0		31.8		35.8	
Existing Baseline	Interior - Pre 1976, Elec W A/C	18,043			\$1,025	\$500	\$1,525		\$0.00	15						
Upgrade 1	Air Source Heat Pump W A/C	12,443	5,600	5,992	\$3,025	\$300	\$3,325	\$1,800	\$0.00	15	5.7		6.5		7.3	
Upgrade 2	Advanced Cold Climate Heat Pump COP of 2.8 at 17 F.	7,217	10,828	11,584	\$4,025	\$300	\$4,325	\$2,800	\$0.00	15	3.8		4.4		4.9	
Upgrade 3	Ground Source Heat Pump W A/C	6,683	11,360	12,156	\$19,000	\$6,000	\$25,000	\$23,475	\$0.00	15	21.2		24.0		27.0	

Notes:

CCEs are based on Energy Savings 2, which include line losses.

Line Losses

Value used:

7%

Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.

Based on a query of the Residential End-Use Survey database, forced air systems are only 2% of electrically-heated homes.

Existing homes with baseboard electric as the primary heat source, but with a central air conditioning system and ducts are also extremely rare.

The baseline house is therefore assumed to have electric baseboard, so the replacement of the heating system with a heat pump would require the installation of ductwork.

Full cost is used because electric baseboard systems do not fail all at once, requiring complete replacement.

The advanced cold climate heat pump is capable of a COP of 2 at 0 F, and 2.4 at 10 F. a seasonal COP of 2.5 has been used in the analysis.

The incremental cost is based on literature that states costs of US\$800 to \$1,000 compared to the standard heat pump (Upgrade 1), for units in the 3 to 4 Ton range designed for residential applications.

- Advanced Mechanical Design

Apartment (per sq foot)

1

Exhibit B.21
Energy Efficiency Upgrades
Cost and Performance Data
- Advanced Building

Type	Technology	Annual Consumption kWh/yr	Energy Svngs 1 kWh/year	Energy Svngs 2 kWh/year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (\$/kWh)				
					Capital	Installation	Full	Incremental			D.R. = 6.00%	D.R. = 8.00%	D.R. = 10.00%		
Detached New Building Baseline	Building with elec. Baseboard, conforming to CBC 1998	10,700													
Upgrade 1 R 2000		8,524	2,176	2,328	\$0	\$0	\$0	\$0	\$0.00	50	Full	Incr.	Full	Incr.	Incr.
Apartment (per sq foot)															
New Bldg. Baseline	New commercial 100,000 ft² building with an electrical energy intensity (BEPI) of 10 kWh/ft²·yr	10.0													26.0
Upgrade 1	Integrated Design Approach to 25% below current construction	7.5	2.5	2.7	\$0	\$0	\$0	\$0	\$0.00	35					
Upgrade 2	Integrated Design Approach to 40% below current construction	6.0	4.0	4.3	\$3.00	\$0	\$3	\$3	\$0.00	35					
									</						

Notes:
 CCEs
 Line Losses

CCEs are based on Energy Savings 2, which include line losses.
 Value used: 7%
 Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.

Exhibit B.22
Energy Efficiency Upgrades
Cost and Performance Data
- Window Upgrade - Existing Buildings

Type		Technology	Annual Consumption kWh/year	Energy Svngs 1 kWh/year	Energy Svngs 2 kWh/year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (¢/kWh)											
						Capital	Installation	Full	Incremental			D.R. =		D.R. =		D.R. =							
												6.00%	8.00%	6.00%	8.00%	6.00%	8.00%	6.00%	8.00%				
Single Family/Duplex																							
Existing Baseline		double vinyl	10,655				\$9,878	\$0	\$9,878														
		double low e																					
Upgrade 1		argon	9,185	1,470	1,573	\$10,737	\$0	\$10,737	\$859	\$0.00	25									6.0			
Row																							
Existing Baseline		double vinyl	4,600				\$10,493	\$0	\$10,493														
		double low e																					
Upgrade 1		argon	3,240	1,360	1,455	\$11,406	\$0	\$11,406	\$913	\$0.00	25									6.9			
Apartment Suite (per sq foot)																							
Existing Baseline		double vinyl	5				\$1	\$0	\$0														
		double low e																					
Upgrade 1		argon	2.5	2.1	2.2	\$2.90	\$0	\$0	\$3	\$0.00	25									14.2			

Notes:

CCEs are based on Energy Savings 2, which include line losses.

Line Losses

Value used:

7%

Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.

Impact of upgrade modeled in Hot 2000

Cost of window upgrades obtained from sales data and from BC Hydro.

Exhibit B.23
Energy Efficiency Upgrades
Cost and Performance Data
Television

Type	Technology	Annual Consumption kWh/year	Energy Svngs 1 kWh/year	Energy Svngs 2 kWh/year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (¢/kWh)					
					Capital	Installation	Full	Incremental			D.R. = Full	D.R. = Full	D.R. = Full	D.R. = Full	D.R. = Full	D.R. = Full
Existing Baseline	Conventional Television Set	513			\$400	\$0	\$400		\$0.00	11						
upgrade 1	Energy Star Compliant Television	416	97	104	\$405	\$0	\$405	\$5	\$0.00	11						

Notes:

CCEs are based on Energy Savings 2, which include line losses.

Line Losses Value used: 7%

Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.

Typical new appliance cost and energy obtained from published data

Incremental cost and performance data from LBL.

Estimate is 19% reduction in energy use.

Prices listed are based on current list price. Prices vary in the marketplace. The incremental cost for the upgrade is the key variable used in calculating the CCE.

Exhibit B.24
Energy Efficiency Upgrades
Cost and Performance Data
- Flat Screen Monitor

Type	Technology	Connected Load W/monitor	Hours of Operation hrs/year	Annual Consumption kWh/yr	Energy Svgs 1 kWh/year	Energy Svgs 2 kWh/year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (\$/kWh)					
							Capital	Installation	Full	Incremental			D.R. =	6.00%	D.R. =	8.00%	D.R. =	10.00%
Existing Baseline	baseline	90	1278	115			\$250	\$0	\$250				Full	Incr.	Full	Incr.	Full	Incr.
Upgrade 1	flat screen	25	1278	32	83	89	\$577	\$0	\$577	\$327	\$0.00	5	Full	87.4	Full	92.2	Full	97.1

Notes:
 CCEs are based on Energy Savings 2, which include line losses.
 Line Losses Value used: 7%
 Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.
 Baseline Typical average demand of monitors based on Energy Star and DOE literature
 Upgrade Cost obtained from in-store survey

Exhibit B.25
Energy Efficiency Upgrades
Cost and Performance Data
- Energy Star Compliant Computer

Type	Technology	Annual Consumption kWh/comp	Energy Savings 1 kWh/year	Energy Savings 2 kWh/year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (\$/kWh)					
					Capital	Installation	Full	Incremental			D.R = Full	6.00% Incr.	D.R = Full	8.00% Incr.	D.R = Full	10.00% Incr.
Existing Baseline	baseline	130			\$1,200	\$0	\$1,200		\$0.00	5						
Upgrade 1	Energy Star Power Mgt Operating	61	69	74	\$1,200	\$0	\$1,200	\$0	\$0.00	5		0.0		0.0		0.0

Notes:
 CCEs are based on Energy Savings 2, which include line losses.
 Line Losses: 7%
 Value used: 7%
 Line losses used in this analysis are: Area transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.
 LBL doc (see ref section)
 Cost and performance obtained from in-store survey

Exhibit B.28
Energy Efficiency Upgrades
Cost and Performance Data
- Consumer Electronics - Reduced Standby Losses

Type	Technology	Connected Load W/Device	Hours of Operation hrs/year	Annual Cons. kWh/Device	Energy Svs 1 kWh/year	Energy Svs 2 kWh/year	Technology Costs		Installed Costs		Incr. Ann. O&M	Life (yrs)	CCEs (\$/kWh)			
							Capital	Installation	Full	Incremental			DR = Full	DR = Full	DR = Full	DR = Full
Existing Baseline	baseline average power in standby mode	3.4	8000	20			\$0	\$0	\$0	\$0	\$0.00	4				
Upgrade 1	1 watt stand by mode	1	8000	8	14	15	\$0	\$0	\$0	\$0	\$0.00	4				

Notes:
CCEs are based on Energy Savings 2, which include line losses.
Line Losses
Value used
7%
Line losses used in this analysis are: Area Transmission (3%) and distribution (4%). Consistent with the approach applied to other electricity options, bulk transmission losses are omitted. Further detail is provided in Section 4 of the main report.
Based on LBL survey of standby losses
Based on LBL survey of standby losses
Note cost is assumed to be "0" as all appliances tested had at least 1 model that meet the 1 watt performance level.

APPENDIX C

- **Achievable Potential Background
Materials**

INTRODUCTION

Appendix C contains the following background information related to the development of Achievable Potential for the residential sector:

- Exhibit 1 - Summary of Action Profiles
- Exhibit 2 - Generalized Barriers, which were used for reference and/or refinement during the discussion of the Action Profiles
- Exhibit 3 - Summary of Potential External Influences, which were used for reference and/or refinement during the discussion of the Action Profiles
- Exhibit 4 - Generalized Interventions, which were used for reference and/or refinement when reviewing the Action Profiles
- 7 Action Profiles (in the order shown in Exhibit 1); each Action Profile is presented on two pages. The first page provides a "high level" description of the Action; the second page presents the quantitative information that was developed during the workshop and in the follow up consultations.

In addition, Attachment A provides summary information on previous Power Smart program results.

Exhibit 1
Summary of Action Profiles

Action		Target End Use(s)	Target Vintage(s)	Target Segments & Technologies	% of Total Economic Savings (approx)
#	Name				
R1	Residential Lighting Efficiency	Lighting	Both	- All - Incandescent to CFL - All - Holiday lights to LED - Apartment Corridors - T12 to T8 electronic	35
R2	Energy Star Appliances and Electronic Equipment	Appliances, Computers and TVs	Both	- All - Refrigerators, Freezers, Clothes washers - All - Dishwashers, Computers, Colour TVs - Ceiling and ventilator fans	28
R3	Efficient Water Heating	DHW	Both	- All - DHW blanket - electric DHW - All - Heat trap + heat pump water heater-electric DHW	16
R4	Energy Efficient New Apartment Design	Building Envelope	New	Apt - integrated design to 40% below current	1
R5	Efficient Blower Motors	Ventilation	Both	SFD/Duplex - ECPM blower motors - forced air systems	1
R6	Advanced Heat Pumps	Space Heating/cooling	New	SFD/Duplex - - Cold Climate Heat Pump	4
R7	Comprehensive Weatherization	Building Envelope	Both	- SFD/Duplex, Row - envelope & temperature setback - SFD/Duplex, Row - window upgrades - Apartment - temperature setback - Mobile/Other - envelope & temperature setback	5
R8	Miscellaneous	Stand by losses	Both	Treatment to be discussed with BCH	11

Exhibit 2 Generalized Barriers

Customer EE Awareness	• Awareness that EE opportunities & products exist • Awareness of benefits – cost and co-benefit • Customers' technical ability to assess the options.
Product and Service Availability	• Local or national product availability. • Existence of a viable infrastructure of trade allies. • Vendor or trade ally awareness of the efficiency options and their understanding of the technical issues.
Financing	• Access to appropriate financing • Size of required EE investment vs asset base • Payback Ratio – Actual vs Required
Transaction Costs	• Level of effort/hassle required to become informed, select products, choose contractor(s) and install
Perceived Risk/Reward	• Level of perceived risk that the EE product may not perform as promised • Level of positive external/personal recognition for "doing the right thing" by installing the EE measure(s)
Split Incentive/Motivatioin	• Level to which the incentives of the agent charged with purchasing the EE are aligned with those of the person(s) that would benefit.
Regulatory	• Codes or standards that prohibit implementation of innovative EE technologies • Level of EE performance that is required in codes or standards

(Source: Nelson 1996 and ACEEE, 2001)

Exhibit 3 Potential External Influences on Residential Sector Actions

- Federal government ratification of Kyoto Agreement is expected to increase customer awareness and willingness to participate; the expected infusion of additional federal climate change money is also likely to create additional opportunities for federal government/BCH program partnerships
- U.S. federal government energy policy is not currently supportive of Kyoto. Given the high degree of linkages between Canadian and U.S. markets and manufacturing, "go-it-alone" changes to standards and regulations specifying required levels of equipment efficiency will be difficult
- The industry is currently suffering from a credibility gap based on past construction problems.
- The city of Vancouver uses ASHRAE 90.1, (1990). There may be a need to update existing energy code requirements to make them consistent. In other jurisdictions, lighting, ventilation and envelope requirements are based on the BCBC, which makes immediate implementation of LEED outside the lower mainland more challenging.
- The GVRD is active in developing a green building strategic plan as part of the Sustainable Region Initiative; this is expected to complement BCH efforts and may provide opportunities to leverage program and partnership opportunities.
- BC gas currently has a program in place for high efficient furnace replacements. This may provide an opportunity to develop a program jointly with BC Gas for promotion of ECM blower motors.
- The majority of residential furnaces are manufactured in the United States, making it more difficult to implement furnace motor efficiency standards at a provincial level.

Exhibit 4
Generalized Interventions

Ref	Name	Sample Descriptions
A	Information & Promotion	• Passive provision of information to market participants re: EE opportunities and benefits. • Product or building EE labelling • Employee EE awareness programs
B	Technical services to customers	• Energy audits (walk-through, pre-feasibility, investment grade) • Web based self analysis • Metering • Power quality analysis • Design assistance • Energy performance benchmarking • Commissioning and recommissioning • Direct management of third party utilities • Third party verification • Post installation technical support re: EE equipment.
C	Specialized customer support	• Provide solutions to sub sector specific EE constraints e.g., Assist property managers/owners to establish language in lease agreements enabling cost recovery of EE capital investments. • Provide market recognition for customer EE achievements
D	Vendor and Customer Links	• Providing customer contacts to contractors • Providing contractor contacts to customers • Contractor certification • Providing sales, marketing and/or technical training about products or services to individuals responsible for selling it. • Vertical integration of market between upstream and downstream market actors (i.e., forming a relationship between contractors and suppliers).
E	Trade Ally Training	• Providing training to trade-allies so that they better understand new or existing practices or procedures • O&M training • Recommissioning and commissioning training
F	Financial incentives	• Product rebates to customer • Product rebates to vendor • Performance incentives (\$/kW of \$/MWh) • Auction bids from manufacturers • Below market interest rate loans with repayment through utility bills • Revolving fund for feasibility studies • Direct audit incentives • Subsidize industrial process improvements
G	Rates	• Demand bidding/buy-back programs (can be combined with real time pricing) • Time of use rates • Real time pricing • Marginal price, trailing block • Power exchanges- bringing together buyers and sellers of power • Curtailable and interruptible power. • Emission credits- perhaps considering GHG credit purchase for customer DSM.
H	EE Procurement	• Utility bulk purchases target product to bring price down and establish agreement with trade allies to sell the product. • Development of EE procurement guidelines for Municipal, C/I sectors
I	Standards and Regulations	• Product energy test standards and energy performance rating • Standardized protocols for installation and operation of energy equipment • Regulations prescribing minimum energy efficiency performance levels
J	Emerging technology accelerated market adoption	• Providing demonstration of the use/performance of energy efficient technologies to market actors • Bulk purchase-see # 8 • Take equity position in companies developing technologies

Residential Action Profiles

Action Profile R 1 - Residential Lighting Efficiency

Overview:

This Action will encourage replacement of existing incandescent room and holiday lighting with CFL and LED technologies in all existing and new residential dwellings. Despite increased use of CFLs, the Residential End Use Survey confirmed that incandescent lights remain the primary means of lighting in BC homes. This Action will also promote the retrofit of existing T12 fluorescent lighting systems with T8 electronic fluorescent systems in apartment buildings.

The broad strategy envisioned for this Action consists of:

- strong up-front promotional efforts directed towards customers, vendors and trade allies
- financial incentives targeted to both customers and vendors for the first 5 years to boost market momentum
- a BCH exit strategy that involves accelerated changes to provincial regulations affecting the minimum energy performance of lamps and ballasts. For example, potential targets for fluorescent lamps could be minimum efficacy levels of 95+ lumens/watt for fluorescent lamps promoting the inclusion of only the highest performance equipment such as second generation T8 systems.

Target Technologies and Sub Segments:

- Incandescent bulbs to CFL – all sub segments
- Incandescent holiday lights to LED – all segments
- T12 fluorescent lighting to T8 electronic – Apartment corridors and common areas.

Target Stakeholder Group:

Building owners, occupants and maintenance personnel, including

- Homeowners
- Homeowners who are contemplating a renovation on their home
- Building owners who pay for operating expenditures
- Housing authorities that subsidize operating costs of building occupants
- Vendors and trade allies

Key Barriers and Interventions:

Experience to date indicates that the most significant barriers affecting this opportunity are:

- lack of awareness – e.g., re: the benefits of CFLs; knowledge of LEDs
- financing – e.g. a higher capital cost for CFLs, LEDs and T8 systems

This Action will address these barriers by combining the following interventions:

- Information and promotion – e.g., in-store technical information on CFLs, LEDs
- Financial incentives, such as mail in rebates for CFL and LED holiday light purchases
- Technical services – e.g., as part of the Energuide energy audit (R1), a lighting audit could also be completed and customer opportunities for EE lighting evaluated

Time Frame:

Start in 2003; financial incentives to 2008; standards and labeling initiatives post 2008.

Relationship to Other Actions:

This Action complements activities envisioned under Actions R2.

Action Profile R 1 - Residential Lighting Efficiency

Overview:

This Action will encourage replacement of existing incandescent room and holiday lighting with CFL and LED technologies in all existing and new residential dwellings. Despite increased use of CFLs, the Residential End Use Survey confirmed that incandescent lights remain the primary means of lighting in BC homes. This Action will also promote the retrofit of existing T12 fluorescent lighting systems with T8 electronic fluorescent systems in apartment buildings.

The broad strategy envisioned for this Action consists of:

- strong up-front promotional efforts directed towards customers, vendors and trade allies
- financial incentives targeted to both customers and vendors for the first 5 years to boost market momentum
- a BCH exit strategy that involves accelerated changes to provincial regulations affecting the minimum energy performance of lamps and ballasts. For example, potential targets for fluorescent lamps could be minimum efficacy levels of 95+ lumens/watt for fluorescent lamps promoting the inclusion of only the highest performance equipment such as second generation T8 systems.

Target Technologies and Sub Segments:

- Incandescent bulbs to CFL – all sub segments
- Incandescent holiday lights to LED – all segments
- T12 fluorescent lighting to T8 electronic – Apartment corridors and common areas.

Target Stakeholder Group:

Building owners, occupants and maintenance personnel, including

- Homeowners
- Homeowners who are contemplating a renovation on their home
- Building owners who pay for operating expenditures
- Housing authorities that subsidize operating costs of building occupants
- Vendors and trade allies

Key Barriers and Interventions:

Experience to date indicates that the most significant barriers affecting this opportunity are:

- lack of awareness – e.g., re: the benefits of CFLs; knowledge of LEDs
- financing – e.g. a higher capital cost for CFLs, LEDs and T8 systems

This Action will address these barriers by combining the following interventions:

- Information and promotion – e.g., in-store technical information on CFLs, LEDs
- Financial incentives, such as mail in rebates for CFL and LED holiday light purchases
- Technical services – e.g., as part of the Energuide energy audit (R1), a lighting audit could also be completed and customer opportunities for EE lighting evaluated

Time Frame:

Start in 2003; financial incentives to 2008; standards and labeling initiatives post 2008.

Relationship to Other Actions:

This Action complements activities envisioned under Actions R2.

Residential Sector - Action R1 - Lighting Efficiency

Sub Sector	SFD/Duplex			Low-rise			Row			Mobile/Other			High-rise		
Approx % of Action Savings	62%			18%			7%			4%			8%		
Eco Savings (GWh) to 2015/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
	761	823	892	225	244	264	90	97	105	55	59	64	101	110	119
Participant Definition	Dwellings			Apt. units and corridors			Dwellings			Dwellings			Apt. units and corridors		
Total Applicable Dwellings ('000s)	886	73	81	344	28	31	136	12	12	111	9	10	155	13	14
Prime Target	All			All			All			All			All		
Major Technologies &	Technology			Technology			Technology			Technology			Technology		
Contribution to Economic Savings	Inc. to CFL	80%	% of Eco	Inc. to CFL	50%	% of Eco	Inc. to CFL	85%	% of Eco	Inc. to CFL	75%	% of Eco	Inc. to CFL	50%	% of Eco
	Holiday/Ext.	20%	% of Eco	Corridor	50%	% of Eco	Holiday/Ext.	15%	% of Eco	Holiday/Ext.	25%	% of Eco	Corridor	50%	% of Eco
Approx Svgs/Dwelling/suite	858			655			656			491			655		
Savings Adjustment Factor (if applicable)	okay			okay			okay			okay			okay		
Approx. CCE (£/kWh)	1.7			3.6			1.7			1.7			3.6		
Approx. Customer Payback (yrs)	3.6			3.2			3.6			3.8			3.2		
Participation Rate (% of Eco svgs)	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	15	30	45	15	30	45	15	30	45	15	30	45	15	30	45
Upper	25	50	90	25	50	90	25	50	90	25	50	90	25	50	90
Action Savings, by Year (GWh)	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	114	247	401	34	73	119	13	29	47	8	18	29	15	33	54
Upper	190	411	803	56	122	238	22	48	95	14	30	58	25	55	107
Total Savings, by Year (GWh)													05/06	10/11	15/16
Economic Savings													1,231	1,332	1,444
Most Likely													185	400	650
Upper													308	666	1,300

Action Profile R 2 - Energy Star Appliances and Equipment

Overview:

This Action will encourage the purchase of Energy Star compliant home appliances and electronics as well as windows and heating/air conditioning equipment through promotion of the Energy Star brand. It is assumed that there is significant opportunity for leveraging complementary federal government initiatives in this area.

The broad strategy envisioned for this Action consists of:

- strong up-front promotional efforts directed towards customers, vendors and trade allies, including in-store promotions and technical information
- financial incentives targeted to both customers and vendors for the first 5 years to boost market momentum
- a BCH exit strategy that involves accelerated changes to provincial regulations affecting the minimum energy performance of major appliances e.g., Energy Star performance levels could provide the target levels for revised regulations.

Target Technologies and Sub Segments:

- Energy Star appliances, computers, colour TVs – all segments
- Freezers to EE freezers – all segments
- Windows and heating/cooling equipment – all segments
- Ceiling and exhaust fans – all segments

Target Stakeholder Group:

- Building owners, occupants and maintenance personnel, including:
 - Homeowners
 - Homeowners who are contemplating a renovation on their home
 - Building owners who pay for operating expenditures
 - Housing authorities that subsidize operating costs of building occupants
- Vendors and trade allies

Key Barriers and Interventions:

Experience to date indicates that the most significant barriers affecting this opportunity are:

- lack of consumer information,
- higher first cost of products

This Action will address these barriers by combining the following interventions:

- Information and promotion – e.g., energy and cost savings; appliance labelling - an energy star rating in conjunction with an energuide label will provide a performance metric and a benchmark to improve consumer knowledge of product energy efficiency
- Financing – e.g., main in rebates to customers plus vendor incentive for promotion and handling
- Standards and regulations – e.g., appliance standards increased to Energy Star levels

Time Frame:

Start up promotions in 2003; mail in rebates and vendor incentives to 2008; increased product performance standards and regulations post 2008.

Relationship to Other Actions:

This Action complements activities envisioned under Actions C6 and R7. The Energy Star brand also applies to windows and heating/cooling equipment.

Action Profile R 2 - Energy Star Appliances and Equipment

Overview:

This Action will encourage the purchase of Energy Star compliant home appliances and electronics as well as windows and heating/air conditioning equipment through promotion of the Energy Star brand. It is assumed that there is significant opportunity for leveraging complementary federal government initiatives in this area.

The broad strategy envisioned for this Action consists of:

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Target Technologies and Sub Segments:

- Energy Star appliances, computers, colour TVs – all segments
- Freezers to EE freezers – all segments
- Windows and heating/cooling equipment – all segments
- Ceiling and exhaust fans – all segments

Target Stakeholder Group:

- Building owners, occupants and maintenance personnel, including:
 - Homeowners
 - Homeowners who are contemplating a renovation on their home
 - Building owners who pay for operating expenditures
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Key Barriers and Interventions:

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- Standards and regulations – e.g., appliance standards increased to Energy Star levels

Time Frame:

Start up promotions in 2003; mail in rebates and vendor incentives to 2008; increased product performance standards and regulations post 2008.

Relationship to Other Actions:

This Action complements activities envisioned under Actions C6 and R7. The Energy Star brand also applies to windows and heating/cooling equipment.

Residential Sector - Action R2a - Energy Star Refrigerators

Sub Sector	SFD/Duplex			Low-rise			Row			Mobile/Other			High-rise		
	75%			7%			10%			8%			3%		
Approx % of Action Savings	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Eco Savings (GWh) to 2015/22	132	226	290	11	21	27	16	29	38	14	24	31	5	9	12
Participant Definition	Refrigerators			Refrigerators			Refrigerators			Refrigerators			Refrigerators		
Eligible Units per Period ('000s)	430	435	438	130	134	139	55	58	62	45	46	47	59	61	63
Prime Target	Refrigerators being replaced or purchased new			Refrigerators being replaced or purchased new			Refrigerators being replaced or purchased new			Refrigerators being replaced or purchased new			Refrigerators being replaced or purchased new		
Reference Case Replacement Appliance Energy (kWh/yr)	725	631	565	456	447	418	709	630	576	729	632	563	456	447	418
Economic Scenario Replacement Appliance Energy (kWh/yr)	417	417	417	372	372	372	417	417	417	417	417	417	372	372	372
Approx Svs/Fridge Savings Adjustment Factor (if applicable)	308	214	148	84	75	46	292	213	159	312	215	146	84	75	46
Adjusted Svs/Fridge	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Approx. CCE (g/kWh)	308	214	148	84	75	46	292	213	159	312	215	146	84	75	46
Approx. Customer Payback (yrs)	4.3	4.3	4.3	0.0	0.0	0.0	4.3	4.3	4.3	4.3	4.3	4.3	0.0	0.0	0.0
Participation Rate (% of eligible units during period)	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	15	50	85	10	33	55	11	38	64	10	33	55	10	33	55
Upper	25	75	100	16	49	100	19	58	100	16	49	100	16	49	100
1000s Units Affected	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
During Period	65	217	372	13	44	77	6	22	39	4	15	26	6	20	35
Most Likely	108	326	438	21	65	139	10	33	62	7	23	47	10	30	63
Upper	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Cumulative	65	282	654	13	56	133	6	28	67	4	19	45	6	25	60
Most Likely	108	434	871	21	87	225	10	43	105	7	30	77	10	39	102
Upper	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Annual Savings in Milestone Year (GWh)	20	47	55	1	3	3	2	5	6	1	3	4	0	1	2
From Actions in the Period	33	70	65	2	5	6	3	7	10	2	5	7	1	2	3
Most Likely	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Cumulative	20	66	122	1	4	8	2	8	13	1	5	8	0	2	4
Most Likely	33	103	168	2	7	13	3	10	20	2	7	14	1	3	6
Upper	Total Savings, by Year (GWh)			Total Savings, by Year (GWh)			Total Savings, by Year (GWh)			Total Savings, by Year (GWh)			Total Savings, by Year (GWh)		
	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
	178	309	399	178	309	399	178	309	399	178	309	399	178	309	399
	25	84	154	25	84	154	25	84	154	25	84	154	25	84	154
	41	130	221	41	130	221	41	130	221	41	130	221	41	130	221

Residential Sector - Action R2b - Energy Star Televisions

Sub Sector	SFD/Duplex	Low-rise	Row	Mobile/Other	High-rise
Approx % of Action	63%	13%	5%	7%	7%
Eco Savings (GWh) to 2015/16	05/06 10/11 15/16 58 122 194	05/06 10/11 15/16 12 25 41	05/06 10/11 15/16 7 16 27	05/06 10/11 15/16 7 14 21	05/06 10/11 15/16 6 14 23
Participant Definition	Televisions	Televisions	Televisions	Televisions	Televisions
Eligible Units per Period ('000s)	599 662 735	122 140 161	74 91 112	67 74 81	66 77 89
Prime Target	Televisions being replaced or purchased new	Televisions being replaced or purchased new	Televisions being replaced or purchased new	Televisions being replaced or purchased new	Televisions being replaced or purchased new
Reference Case Replacement Appliance Energy (kWh/yr)	513 513 513	513 513 513	513 513 513	513 513 513	513 513 513
Economic Scenario Replacement Appliance Energy (kWh/yr)	416 416 416	416 416 416	416 416 416	416 416 416	416 416 416
Approx Svgs/TV	97 97 97	97 97 97	97 97 97	97 97 97	97 97 97
Savings Adjustment Factor (if applicable)	0.80 0.80 0.80	0.80 0.80 0.80	0.80 0.80 0.80	0.80 0.80 0.80	0.80 0.80 0.80
Adjusted Svgs/TV	78 78 78	78 78 78	78 78 78	78 78 78	78 78 78
Approx. CCE (¢/kWh)	0.7	0.7	0.7	0.7	0.7
Approx. Customer Payback (yrs)	0.9	0.9	0.9	0.9	0.9
Participation Rate (% of eligible units during period)	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely	50 80 100	50 80 100	50 80 100	50 80 100	50 80 100
Upper	75 100 100	75 100 100	75 100 100	75 100 100	75 100 100
'000s Units Affected During Period	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely	299 530 735	61 112 161	37 73 112	34 59 81	33 61 89
Upper	449 662 735	91 140 161	55 91 112	50 74 81	49 77 89
Cumulative	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely	299 829 1565	61 173 333	37 110 221	34 93 173	33 94 184
Upper	449 1112 1847	91 231 392	55 146 258	50 124 205	49 126 216
Annual Savings in Milestone Year (GWh)	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
From Actions in the Period	23 41 57	5 9 12	3 6 9	3 5 6	3 5 7
Most Likely	35 51 57	7 11 12	4 7 9	4 6 6	4 6 7
Upper	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Cumulative	23 64 121	5 13 26	3 9 17	3 7 13	3 7 14
Most Likely	35 86 143	7 18 30	4 11 20	4 10 18	4 10 17
Upper					
Total Savings, by Year (GWh)					
05/06 10/11 15/16					
Economic Savings					
Achievable - Most Likely					
90 191 305					
Achievable - Upper					
54 135 226					

Sub Sector	SFD/Duplex	Low-rise	Row	Mobile/Other	High-rise
Approx % of Action Savings	68%	7%	8%	14%	3%
Eco Savings (GWh) to 2015/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Appliance Savings	5 11 21	1 1 3	1 1 3	0.4 1 2	0.3 1 1
DHW Savings	48 90 121	4 8 11	5 10 14	11 21 28	2 4 5
Participant Definition	Clothes Washers	Clothes Washers	Clothes Washers	Clothes Washers	Clothes Washers
Eligible Units per Period ('000s)	103 106 108	9 9 9	14 14 13	27 28 28	4 4 4
Prime Target	Clothes washers being replaced or purchased new in homes with electric DHW	Clothes washers being replaced or purchased new in homes with electric DHW	Clothes washers being replaced or purchased new in homes with electric DHW	Clothes washers being replaced or purchased new in homes with electric DHW	Clothes washers being replaced or purchased new in homes with electric DHW
Reference Case Replacement Appliance Energy (kWh/yr)	848 788 719	759 721 646	672 659 615	602 635 551	823 760 672
Economic Scenario Replacement Appliance Energy (kWh/yr)	337 337 337	193 193 193	253 253 253	265 265 265	193 193 193
Approx Svgs/Washer	511 452 382	566 528 454	406 406 362	427 370 286	630 573 479
Savings Adjustment Factor (if applicable)	1.00 1.00 1.00	1.00 1.00 1.00	1.00 1.00 1.00	1.00 1.00 1.00	1.00 1.00 1.00
Adjusted Svgs/Washer	511 452 382	566 528 454	406 406 362	427 370 286	630 573 479
Approx. CCE (¢/kWh)	4.9	4.9	4.9	4.9	4.9
Approx. Customer Payback (yrs)	7.2	13.2	9.6	9.5	13.2
Participation Rate (% of eligible units during period)	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely Upper	10 25 40	5 15 30	5 15 30	5 15 30	5 15 30
	15 40 80	10 35 75	10 35 75	10 35 75	10 35 75
'000s Units Affected					
During Period	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely Upper	10 27 43	0.4 1 3	1 2 4	1 4 8	0.2 1 1
	16 42 86	1 3 7	1 5 10	3 10 21	0.4 1 3
Cumulative	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely Upper	10 37 80	0.4 2 4	1 3 7	1 6 14	0.2 1 2
	16 58 144	1 4 10	1 6 16	3 12 33	0.4 2 5
Annual Savings in Milestone Year (GWh) From Actions in the Period	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely Upper	5 12 16	0.2 1 1	0.3 1 1	0.6 2 2	0.1 0.3 0.5
	8 18 33	0.5 2 3	1 2 4	1 4 6	0.2 0.8 1.4
Cumulative	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely Upper	5 17 34	0.2 1 2	0.3 1 3	0.8 2 5	0.1 0.4 1
	8 27 60	0.5 2 5	1 3 6	1 5 11	0.2 1 2
Total Savings, by Year (GWh)					
Economic Savings					
Achievable - Most Likely					
Achievable - Upper					

Sub Sector	SFD/Duplex	Low-rise	Row	Mobile/Other	High-rise										
Approx % of Action Savings	64%	16%	9%	4%	7%										
Eco Savings (GWh) to 2015/16	05/06 68	10/11 79	15/16 94	05/06 16	10/11 23	15/16 13	05/06 5	10/11 6	15/16 7	05/06 7	10/11 8	15/16 10			
Participant Definition	Computers	Computers	Computers	Computers	Computers	Computers	Computers	Computers	Computers	Computers	Computers	Computers			
Eligible Units per Period ('000s)	982	165	220	226	44	61	119	29	39	69	12	15	102	20	29
Prime Target	Computers being replaced or purchased new	Computers being replaced or purchased new	Computers being replaced or purchased new	Computers being replaced or purchased new	Computers being replaced or purchased new	Computers being replaced or purchased new	Computers being replaced or purchased new	Computers being replaced or purchased new	Computers being replaced or purchased new	Computers being replaced or purchased new	Computers being replaced or purchased new	Computers being replaced or purchased new	Computers being replaced or purchased new	Computers being replaced or purchased new	Computers being replaced or purchased new
Reference Case	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
Economic Scenario	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61
Replacement Appliance	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69
Approx Svgs/PC	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Savings Adjustment Factor (if applicable)	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69
Adjusted Svgs/PC	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Approx. CCE (g/kWh)	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Approx. Customer Payback (yrs)	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Participation Rate (% of eligible units during period)	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	20	50	75	20	50	75	20	50	75	20	50	75	20	50	75
Upper	50	75	90	50	75	90	50	75	90	50	75	90	50	75	90
'000s Units Affected	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
During Period	196	82	165	45	22	46	24	14	29	14	6	11	20	10	21
Most Likely	491	123	198	113	33	55	59	22	35	34	9	14	51	15	26
Upper	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Cumulative	196	279	443	45	67	113	24	38	67	14	20	31	20	30	52
Most Likely	491	614	812	113	146	201	59	81	116	34	43	57	51	66	92
Upper															
Annual Savings in Milestone Year (GWh)	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
From Actions in the Period	14	6	11	3	2	3	2	1	2	1	0.4	1	1	1	1
Most Likely	34	9	14	8	2	4	4	1	2	2	1	1	4	1	2
Upper	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Cumulative	14	19	31	3	5	8	2	3	5	1	1	2	1	2	4
Most Likely	34	42	56	8	10	14	4	6	8	2	3	4	4	5	6
Upper															
Total Savings, by Year (GWh)															
Economic Savings															
Achievable - Most Likely															
Achievable - Upper															

Residential Sector - Action R2e - Energy Star Freezers

Sub Sector	SFD/Duplex 82%	Low-rise 4%	Row 8%	Mobile/Other 5%	High-rise 2%
Approx % of Action Savings					
Eco Savings (GWh) to 2015/16	05/06 10/11 15/16 26 50 70	05/06 10/11 15/16 1 2 3	05/06 10/11 15/16 2 5 7	05/06 10/11 15/16 1 3 4	05/06 10/11 15/16 1 1 2
Participant Definition (Eligible Units per Period ('000s))	Freezers 289 292 295	Freezers 14 15 15	Freezers 26 27 29	Freezers 16 17 17	Freezers 9 9 9
Prime Target	Freezers being replaced or purchased new	Freezers being replaced or purchased new	Freezers being replaced or purchased new	Freezers being replaced or purchased new	Freezers being replaced or purchased new
Reference Case (Replacement Appliance Energy (kWh/yr))	410 401 390	357 350 344	409 401 391	411 401 389	357 350 344
Economic Scenario (Replacement Appliance Energy (kWh/yr))	320 320 320	280 280 280	320 320 320	320 320 320	280 280 280
Approx Svgs/Freezer (\$ Savings Adjustment Factor (if applicable))	90 81 70	77 70 64	89 81 71	91 81 69	77 70 64
Adjusted Svgs/Freezer	100 100 100	100 100 100	100 100 100	100 100 100	100 100 100
Approx. CCE (\$/kWh)	90 81 70	77 70 64	89 81 71	91 81 69	77 70 64
Approx. Customer Payback (yrs)	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0
Participation Rate (% of eligible units during period)	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely Upper	15 30 40	10 20 26	11 23 30	10 20 26	10 20 26
Units Affected During Period	20 40 50	13 26 33	15 30 36	13 26 33	13 26 33
Most Likely Upper	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Cumulative	43 88 118	1 3 4	3 6 9	2 3 5	1 2 2
Most Likely Upper	58 117 148	2 4 5	4 8 11	2 4 6	1 2 3
Most Likely Upper	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Annual Savings in Milestone Year (GWh)	43 131 249	1 4 8	3 9 18	2 5 9	1 3 5
From Actions in the Period	58 175 322	2 6 11	4 12 23	2 7 12	1 4 7
Most Likely Upper	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Cumulative	4 7 8	0.1 0.2 0.3	0.3 0.5 1	0.1 0.3 0.3	0.1 0.1 0.2
Most Likely Upper	5 9 10	0.1 0.3 0.3	0.3 1 1	0.2 0.4 0.4	0.1 0.2 0.2
Most Likely Upper	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Annual Savings in Milestone Year (GWh)	4 11 19	0.1 0.3 1	0.3 1 1	0.1 0.4 1	0.1 0.2 0.3
From Actions in the Period	5 15 25	0.1 0.4 1	0.3 1 2	0.2 1 1	0.1 0.3 0.4
Most Likely Upper	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Total Savings, by Year (GWh)	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Economic Savings	32 60 86				
Achievable - Most Likely	4 13 22				
Achievable - Upper	6 17 29				

Sub Sector	SFD/Duplex	Low-rise	Row	Mobile/Other	High-rise
Approx. % of Action Savings	70%	7%	8%	12%	3%
Eco Savings (GWh) to 2015/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Appliance Savings	2 4 6	0.3 1 1	0.2 0.4 1	0.1 0.2 0.3	0.1 0.3 0.5
DHW Savings	13 25 36	1 2 3	2 3 4	3 5 7	0.6 1 2
Participant Definition	Dishwashers	Dishwashers	Dishwashers	Dishwashers	Dishwashers
Eligible Units per Period ('000s)	85 87 89	8 8 8	12 11 11	14 15 15	4 4 4
Prime Target	Dishwashers being replaced or purchased new in homes with electric DHW	Dishwashers being replaced or purchased new in homes with electric DHW	Dishwashers being replaced or purchased new in homes with electric DHW	Dishwashers being replaced or purchased new in homes with electric DHW	Dishwashers being replaced or purchased new in homes with electric DHW
Reference Case (Replacement Appliance Energy (kWh/yr))	707 685 663	474 464 452	556 549 543	660 660 660	490 472 456
Economic Scenario (Replacement Appliance Energy (kWh/yr))	526 526 526	290 290 290	408 408 408	526 526 526	290 290 290
Approx Svgs/Dishwasher	181 159 137	184 174 162	148 141 135	188 160 134	200 182 166
Savings Adjustment Factor (if applicable)	1.00 1.00 1.00	1.00 1.00 1.00	1.00 1.00 1.00	1.00 1.00 1.00	1.00 1.00 1.00
Adjusted Svgs/Dishwasher	181 159 137	184 174 162	148 141 135	188 160 134	200 182 166
Approx. CCE (¢/kWh)	0.0	0.0	0.0	0.0	0.0
Approx. Customer Payback (yrs)	0.0	0.0	0.0	0.0	0.0
Participation Rate (% of eligible units during period)	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely Upper	40 80 100	40 80 100	40 80 100	40 80 100	40 80 100
000s Units Affected	60 100 100	60 100 100	60 100 100	60 100 100	60 100 100
During Period	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely Upper	34 70 89	3 7 8	5 9 11	6 12 15	1 3 4
Cumulative	51 87 89	5 8 8	7 11 11	8 15 15	2 4 4
Most Likely Upper	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
000s Units Affected	34 104 192	3 10 19	5 14 25	6 17 32	1 4 8
Annual Savings in Milestone Year (GWh)	51 138 227	5 14 22	7 19 29	8 23 38	2 6 9
From Actions in the Period	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely Upper	6 11 12	0.6 1 1	1 1 1	1 2 2	0.3 0.5 0.6
Cumulative	9 14 12	1 1 1	2 2 2	2 2 2	0.7 0.7 0.6
Most Likely Upper	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
000s Units Affected	6 17 29	0.6 2 3	1 2 3	1 3 5	0.3 0.8 1
Annual Savings in Milestone Year (GWh)	9 23 35	1 2 4	1 3 4	2 4 6	0.4 1 2
From Actions in the Period	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely Upper	6 11 12	0.6 1 1	1 1 1	1 2 2	0.3 0.5 0.6
Cumulative	9 14 12	1 1 1	2 2 2	2 2 2	0.7 0.7 0.6
Most Likely Upper	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
000s Units Affected	6 17 29	0.6 2 3	1 2 3	1 3 5	0.3 0.8 1
Annual Savings in Milestone Year (GWh)	9 23 35	1 2 4	1 3 4	2 4 6	0.4 1 2
From Actions in the Period	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely Upper	6 11 12	0.6 1 1	1 1 1	1 2 2	0.3 0.5 0.6
Cumulative	9 14 12	1 1 1	2 2 2	2 2 2	0.7 0.7 0.6
Most Likely Upper	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
000s Units Affected	6 17 29	0.6 2 3	1 2 3	1 3 5	0.3 0.8 1
Annual Savings in Milestone Year (GWh)	9 23 35	1 2 4	1 3 4	2 4 6	0.4 1 2
From Actions in the Period	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely Upper	6 11 12	0.6 1 1	1 1 1	1 2 2	0.3 0.5 0.6
Cumulative	9 14 12	1 1 1	2 2 2	2 2 2	0.7 0.7 0.6
Most Likely Upper	05/06 10/11 15/16	05/06 10/11 15/16	05/		

Action Profile R 3 - Efficient Water Heating

Overview:

This Action will promote reduced DHW electricity use in all existing and new residential dwellings. The goal of this Action is to encourage household adoption of efficient electric water heaters, together with more efficient faucets, showerheads and hot water consuming appliances.

The broad strategy envisioned for this Action consists of:

- strong up-front promotional efforts directed towards customers, vendors and trade allies
- financial incentives targeted to both customers and vendors for the first 5 years to boost market momentum
- a BCH exit strategy that involves accelerated changes to provincial regulations affecting the flow rates in shower heads and faucets, together with energy performance levels in major hot water consuming appliances.

Target Technologies and Sub Segments:

- DHW blanket – all segments
- Efficient showerheads and faucets – all segments
- Heat trap – all segments
- Heat pump water heater – all segments

Target Stakeholder Group:

- Homeowners
- Homeowners who are contemplating a renovation on their home
- Building owners who pay for operating expenditures
- Housing authorities that subsidize operating costs of building occupants
- Vendors and trade allies

Key Barriers and Interventions:

Experience to date indicates that the most significant barriers affecting this opportunity are:

- lack of consumer information,
- split incentives in the rental market

This Action will address these barriers by combining the following interventions:

- Technical information
- Financial incentives such as providing heat traps and blankets for free.

Time Frame:

Start in 2003; financial incentives to 2008; standards and labeling initiatives post 2008.

Relationship to Other Actions:

This Action complements activities envisioned under Actions R5, which includes clothes washers and dishwashers.

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Relationship to Other Actions:

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Residential Sector - Action R3a - Aerators and Faucets

Sub Sector	SFD/Duplex			Low-rise			Row			Mobile/Other			High-rise		
Approx % of Action Savings	68%			8%			7%			13%			3%		
Eco Savings (GWh) to 2015/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
	71	69	67	8	8	8	7	7	7	14	14	13	3	3	3
Participant Definition	Dwellings			Dwellings			Dwellings			Dwellings			Dwellings		
Eligible Units per Period ('000s)	220	0	0	38	0	0	33	0	0	68	0	0	16	0	0
Prime Target	Existing dwellings with electric DHW			Existing dwellings with electric DHW			Existing dwellings with electric DHW			Existing dwellings with electric DHW			Existing dwellings with electric DHW		
Reference Case Replacement Appliance Energy (kWh/yr)	2,792	N/A	N/A	1,750	N/A	N/A	2,241	N/A	N/A	2,202	N/A	N/A	1,750	N/A	N/A
Economic Scenario Replacement Appliance Energy (kWh/yr)	2,472	N/A	N/A	1,534	N/A	N/A	2,031	N/A	N/A	1,998	N/A	N/A	1,534	N/A	N/A
Approx Svgs/Dwelling	321	N/A	N/A	216	N/A	N/A	210	N/A	N/A	205	N/A	N/A	216	N/A	N/A
Savings Adjustment Factor (if applicable)	1.00	N/A	N/A	1.00	N/A	N/A	1.00	N/A	N/A	1.00	N/A	N/A	1.00	N/A	N/A
Adjusted Svgs/Dwelling	321	N/A	N/A	216	N/A	N/A	210	N/A	N/A	205	N/A	N/A	216	N/A	N/A
Approx. CCE (\$/kWh)	0.5			0.5			0.5			0.5			0.5		
Approx. Customer Payback (yrs)	0.6			1.0			0.8			0.8			1.0		
Participation Rate (% of eligible units during period)	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0
'000s Units Affected															
During Period	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cumulative	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Upper	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0
Annual Savings in Milestone Year (GWh)															
From Actions in the Period	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0
Upper	1	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0
Cumulative	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
Upper	1	1	1	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
Total Savings, by Year (GWh)															
Economic Savings															
Achievable - Most Likely															
Achievable - Upper															

Note Action is considered economic immediately (all by first milestone). Achievable potential may be spread over a longer period.

Sub Sector	SFD/Duplex	Low-rise	Row	Mobile/Other	High-rise
Approx % of Action Savings	65%	0%	13%	22%	0%
Eco Savings (GWh) to 2015/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Participant Definition	13 13 13	0 0 0	3 3 3	4 4 4	0 0 0
Participable Units per Period (1000s)	Water Heaters	Water Heaters	Water Heaters	Water Heaters	Water Heaters
(Prime Target)	113 0 0	0 0 0	17 0 0	35 0 0	0 0 0
Reference Case (Replacement Appliance Energy (kWh/yr))	New or repl. with std. Insulation (only to 2006)	None	New or repl. with std. Insulation (only to 2006)	New or repl. with std. Insulation (only to 2006)	None
Economic Scenario (Replacement Appliance Energy (kWh/yr))	2,472 2,355 2,355	1,534 1,535 1,535	2,031 1,880 1,883	1,998 1,872 1,870	1,534 1,535 1,535
Approx Svgs/Water heater	115 0 0	0 0 0	154 0 0	125 0 0	0 0 0
Savings Adjustment Factor (if applicable)	0.39 0.39 0.39	0.39 0.39 0.39	0.39 0.39 0.39	0.39 0.39 0.39	0.39 0.39 0.39
Adjusted Svgs/Water heater	45 0 0	0 0 0	60 0 0	48 0 0	0 0 0
Approx. CCE (¢/kWh)	4.5	0.0	3.3	4.1	0
Approx. Customer Payback (yrs)	5.4	0.0	4.0	4.9	0.0
Participation Rate (% of eligible units during period)	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
Upper	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
1000s Units Affected	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
During Period	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
Most Likely	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
Upper	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
Cumulative	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
Upper	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
Annual Savings in Milestone Year (GWh)	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
From Actions in the Period	0.0 0 0	0 0 0	0.0 0 0	0.0 0 0	0 0 0
Most Likely	0.0 0 0	0 0 0	0.0 0 0	0.0 0 0	0 0 0
Upper	0.0 0 0	0 0 0	0.0 0 0	0.0 0 0	0 0 0
Cumulative	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Most Likely	0.0 0.0 0.0	0 0 0	0.0 0.0 0.0	0.0 0.0 0.0	0 0 0
Upper	0.0 0.0 0.0	0 0 0	0.0 0.0 0.0	0.0 0.0 0.0	0 0 0
Total Savings, by Year (GWh)	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16	05/06 10/11 15/16
Economic Savings	20	20	20	20	20
Achievable - Most Likely	0.0	0.0	0.0	0.0	0.0
Achievable - Upper	0.0	0.0	0.0	0.0	0.0

Residential Sector - Action R3c - Heat Pump and Heat Trap

Sub Sector	SFD/Duplex			Low-rise			Row			Mobile/Other			High-rise		
	66%			7%			8%			16%			3%		
Approx % of Action Savings	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Eco Savings (GWh) to 2015/16	5	9	14	0	1	2	1	1	2	1	2	3	0	0	1
Participant Definition	Water Heaters			Water Heaters			Water Heaters			Water Heaters			Water Heaters		
Eligible Units per Period ('000s)	112	116	118	40	40	40	16	16	15	32	34	34	16	16	16
Prime Target	Water heaters being replaced or purchased new			Water heaters being replaced or purchased new			Water heaters being replaced or purchased new			Water heaters being replaced or purchased new			Water heaters being replaced or purchased new		
Reference Case Replacement Appliance Energy (kWh/yr)	2,357	2,355	2,355	1,534	1,535	1,535	1,877	1,880	1,863	1,873	1,872	1,870	1,534	1,535	1,535
Economic Scenario Replacement Appliance Energy (kWh/yr)	2,315	2,315	2,315	1,522	1,522	1,522	1,843	1,843	1,843	1,838	1,838	1,838	1,522	1,522	1,522
Approx Svgs/Water heater	42	40	40	12	13	13	34	37	40	35	34	32	12	13	13
Savings Adjustment Factor (if applicable)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adjusted Svgs/Water heater	42	40	40	12	13	13	34	37	40	35	34	32	12	13	13
Approx. CCE (¢/kWh)	2.9			4.4			3.7			3.5			4.4		
Approx. Customer Payback (yrs)	3.5			5.2			4.4			4.2			5.2		
Participation Rate (% of eligible units during period)	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	5	8	10	3	5	7	4	6	8	3	5	7	3	5	7
Upper	10	15	20	7	10	13	8	11	15	7	10	13	7	10	13
'000s Units Affected															
During Period	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	6	9	12	1.3	2	3	1	1	1	1	2	2	0.5	0.8	1.1
Upper	11	17	24	2.6	4	5	1	2	2	2	3	4	1.1	2	2
Cumulative	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	6	15	27	1.3	3	6	1	2	3	1	3	5	0.5	1.4	2
Upper	11	29	52	2.6	6	12	1	3	5	2	5	10	1.1	3	5
Annual Savings in Milestone Year (GWh)															
From Actions in the Period	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	0.2	0.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
Upper	0.5	0.7	0.9	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
Cumulative	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	0.2	0.6	1.1	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.2	0.0	0.0	0.1
Upper	0.5	1.2	2.1	0.0	0.1	0.1	0.0	0.1	0.2	0.1	0.2	0.3	0.0	0.0	0.1
Total Savings, by Year (GWh)													05/06	10/11	15/16
													Economic Savings		
													Achievable - Most Likely		
													Achievable - Upper		
													7		
													0.3		
													0.8		
													1.4		
													1.6		
													2.8		

Note: Economic potential includes heat pump water heaters, but market barriers are still very significant for this technology. The savings adjustment factor is therefore used to reduce potential to reflect only heat trap savings.

Action Profile R 4 - Energy Efficient New Apartment Building Design

Overview:

This Action will promote high performance new construction through the application of an integrated design approach in all new high-rise apartment buildings. The goal is to design and construct new apartment buildings that, on average, use 2-4kWh/ft² less electricity than the current practice. At this performance level, it is expected that the apartments would qualify for a silver or gold rating under the Leadership in Energy and Environmental Design Program (LEED).

This Action would build on the activity that is currently occurring within the green building market. For example, many developers are beginning to incorporate green features into their design and there is emerging support from regional and provincial levels of governments as well as growing industry support.

The broad strategy envisioned for this Action consists of:

- strong up-front promotional efforts directed towards customers, vendors and trade allies
- financial incentives targeted to both developers and trade allies (e.g., architects/designers) for the first 5 years to boost market momentum
- a BCH exit strategy that involves accelerated changes to provincial regulations affecting the minimum energy performance of buildings such as a Canadian version of LEED with CBIP energy performance targets.

Target Technologies and Sub Segments:

- LEED uses ASHRAE 90.1 as a metric, therefore, this Action would target building envelope, lighting and ventilation systems
- To reduce water consumption, high efficiency dishwashers and washing machine end uses would also be captured

Target Stakeholder Group:

- Developers – e.g., Polygon, Concord etc
- Trade allies – e.g., most architectural firms currently have LEED accredited professionals on staff but other trade ally groups are lagging
- GVRD – e.g., it is promoting green buildings and has established the better buildings partnership; it is potentially developing a green building strategic plan

Key Barriers and Interventions:

Experience to date indicates that the most significant barriers to LEED buildings are:

- split incentives – e.g., developer makes design decisions with no input from the eventual home owner or occupant lack of awareness – e.g., among both the development community and the public
- financing – e.g. a highly competitive industry leaves little room for absorbing the cost of “green” building design
- IDA product/service availability – e.g., the development industry has limited technical transfer or skills training and limited case studies.

This Action will address the above barriers by combining the following interventions:

- Information and promotion – e.g., make owners/developers aware of the benefits of a low energy design
- Specialized customer support – e.g., provide training on lease agreement language to PAMA, UDI, CHBA – BC members and provide public recognition of building owners/operators meeting the high performance levels
- Vendor & customers links – e.g., contractor/customer links; contractor certification
- Technical services to customers – e.g., design assistance
- Trade Ally training – e.g., training of designers
- Financing – e.g., BC Hydro could offer performance based hook-up fees/incentive to the developer (based on the LEED points for energy)
- Standards and regulations – e.g., establish CBIP performance levels within building code.

Time Frame:

Start in 2003; financial incentives to 2008; standards and labeling initiatives post 2008.

Relationship to Other Actions:

This Action complements activities envisioned under Actions C 4 (commercial), R 3 (lighting) and R 4 (appliances).

Action Profile R 4 - Energy Efficient New Apartment Building Design

Overview:

This Action will promote high performance new construction through the application of an integrated design approach in all new high-rise apartment buildings. The goal is to design and construct new apartment buildings that, on average, use 2-4kWh/ft² less electricity than the current practice. At this performance level, it is expected that the apartments would qualify for a silver or gold rating under the Leadership in Energy and Environmental Design Program (LEED).

This Action would build on the activity that is currently occurring within the green building market. For example, many developers are beginning to incorporate green features into their design and there is emerging support from regional and provincial levels of governments as well as growing industry support.

The broad strategy envisioned for this Action consists of:

- strong up-front promotional efforts directed towards customers, vendors and trade allies
- financial incentives targeted to both developers and trade allies (e.g., architects/designers) for the first 5 years to boost market momentum
- a BCH exit strategy that involves accelerated changes to provincial regulations affecting the minimum energy performance of buildings such as a Canadian version of LEED with CBIP energy performance targets.

Target Technologies and Sub Segments:

- LEED uses ASHRAE 90.1 as a metric, therefore, this Action would target building envelope, lighting and ventilation systems
- To reduce water consumption, high efficiency dishwashers and washing machine end uses would also be captured

Target Stakeholder Group:

- Developers – e.g., Polygon, Concord etc
- Trade allies – e.g., most architectural firms currently have LEED accredited professionals on staff but other trade ally groups are lagging
- GVRD – e.g., it is promoting green buildings and has established the better buildings partnership; it is potentially developing a green building strategic plan

Key Barriers and Interventions:

Experience to date indicates that the most significant barriers to LEED buildings are:

- split incentives – e.g., developer makes design decisions with no input from the eventual home owner or occupant lack of awareness – e.g., among both the development community and the public
- financing – e.g. a highly competitive industry leaves little room for absorbing the cost of “green” building design
- IDA product/service availability – e.g., the development industry has limited technical transfer or skills training and limited case studies.

This Action will address the above barriers by combining the following interventions:

- Information and promotion – e.g., make owners/developers aware of the benefits of a low energy design
- Specialized customer support – e.g., provide training on lease agreement language to PAMA, UDI, CHBA – BC members and provide public recognition of building owners/operators meeting the high performance levels
- Vendor & customers links – e.g., contractor/customer links; contractor certification
- Technical services to customers – e.g., design assistance
- Trade Ally training – e.g., training of designers
- Financing – e.g., BC Hydro could offer performance based hook-up fees/incentive to the developer (based on the LEED points for energy)
- Standards and regulations – e.g., establish CBIP performance levels within building code.

Time Frame:

Start in 2003; financial incentives to 2008; standards and labeling initiatives post 2008.

Relationship to Other Actions:

This Action complements activities envisioned under Actions C 4 (commercial), R 3 (lighting) and R 4 (appliances).

Residential Sector - Action R4 - Energy Efficient New Apartment Design

Sub Sector	SFD/Duplex			Low-rise			Row			Mobile/Other			High-rise		
Approx % of Action Savings	0%			62%			0%			0%			38%		
Eco Savings (GWh) to 2015/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
	0	0	0	7	15	24	0	0	0	0	0	0	4	9	15
	None			Dwellings			None			None			Dwellings		
Participant Definition	0	0	0	5	7	7	0	0	0	0	0	0	3	4	3
Total Applicable Dwellings ('000s)	None			New, electrically-heated apartment buildings			None			None			New, electrically-heated apartment buildings		
Prime Target	Technology			% of Eco			Technology			% of Eco			Technology		
Major Technologies & Contribution to Economic Savings				Suites			Suites			Suites			Suites		
				75%									70%		
				Common			Common			Common			Common		
Approx Svgs/Dwelling/suite				1274						1441					
Savings Adjustment Factor (if applicable)															
Approx. CCE (£/kWh)	0.0			6.0			0.0			0.0			6.0		
Approx. Customer Payback (yrs)	0.0			12.5			0.0			0.0			12.5		
Participation Rate (% of Eco svgs)	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely Upper				1	5	15							2	10	30
				2	10	20							4	20	40
Action Savings, by Year (GWh)	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely Upper	0	0	0	0.1	1	4	0	0	0	0	0	0	0.1	1	5
	0	0	0	0.1	1	5	0	0	0	0	0	0	0.2	2	6
Total Savings, by Year (GWh)													05/06	10/11	15/16
													Most Likely		
													0.2		
													0.3		
													11		

Action Profile R 5 - Efficient Blower Motors

Overview:

This Action will promote the increased use of electrically commutated (ECM) motors. The goal of this Action is to reduce the electricity consumption of ventilation and furnace fan motors by promoting the use of electrically commutated motors (ECM) in new fan applications. Forced air, natural gas heated homes are a particular target.

The broad strategy envisioned for this Action consists of:

- strong up-front promotional efforts directed towards customers, vendors and trade allies
- financial incentives targeted to both customers and vendors for the first 5 years to boost market momentum
- a BCH exit strategy that involves accelerated changes to provincial regulations related to motor efficiency levels in furnace blowers and ventilators.

Target Technologies and Sub Segments:

- Permanent split capacitor (PSC) motors to electronically commutated permanent magnet motors (ECPM) - existing and new SFD/Duplex units and all continuously ventilated applications.

Target Stakeholder Group:

- Product manufacturers
- Homeowners
- Homeowners who are contemplating a renovation on their home
- Building owners who pay for operating expenditures
- Housing authorities that subsidize operating costs of building occupants
- Vendors and trade allies

Key Barriers and Interventions:

Experience to date indicates that the most significant barriers to efficient furnace motors are:

- lack of consumer awareness
- financing – first costs are higher

This Action will address these barriers by combining the following interventions:

- Information and promotion – e.g., energy and cost savings plus co-benefits of reduced noise
- Financing – e.g., mail in rebates to customers plus vendor incentive for promotion and handling
- Standards and regulations – e.g., development of a national standard for furnace blowers

Time Frame:

Start in 2003; financial incentives to 2008; standards and labeling initiatives post 2008.

Relationship to Other Actions:

This Action complements activities envisioned under Actions R5 and R7.

Action Profile R 5 - Efficient Blower Motors

Overview:

This Action will promote the increased use of electrically commutated (ECM) motors. The goal of this Action is to reduce the electricity consumption of ventilation and furnace fan motors by promoting the use of electrically commutated motors (ECM) in new fan applications. Forced air, natural gas heated homes are a particular target.

The broad strategy envisioned for this Action consists of:

- strong up-front promotional efforts directed towards customers, vendors and trade allies
- financial incentives targeted to both customers and vendors for the first 5 years to boost market momentum
- a BCH exit strategy that involves accelerated changes to provincial regulations related to motor efficiency levels in furnace blowers and ventilators.

Target Technologies and Sub Segments:

- Permanent split capacitor (PSC) motors to electronically commutated permanent magnet motors (ECPM) - existing and new SFD/Duplex units and all continuously ventilated applications.

Target Stakeholder Group:

- Product manufacturers
- Homeowners
- Homeowners who are contemplating a renovation on their home
- Building owners who pay for operating expenditures
- Housing authorities that subsidize operating costs of building occupants
- Vendors and trade allies

Key Barriers and Interventions:

Experience to date indicates that the most significant barriers to efficient furnace motors are:

- lack of consumer awareness
- financing - first costs are higher

This Action will address these barriers by combining the following interventions:

- Information and promotion - e.g., energy and cost savings plus co-benefits of reduced noise
- Financing - e.g., mail in rebates to customers plus vendor incentive for promotion and handling
- Standards and regulations - e.g., development of a national standard for furnace blowers

Time Frame:

Start in 2003; financial incentives to 2008; standards and labeling initiatives post 2008.

Relationship to Other Actions:

This Action complements activities envisioned under Actions R5 and R7.

Residential Sector - Action R5 - Efficient Blower Motors

Sub Sector	SFD/Duplex			Low-rise			Row			Mobile/Other			High-rise		
	100%			0%			0%			0%			0%		
	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Approx % of Action Savings															
Eco Savings (GWh) to 2015/16															
	25	56	94	0	0	0	0	0	0	0	0	0	0	0	0
Participant Definition	Dwellings			None			None			None			None		
Total Applicable Dwellings ('000s)	100	125	150	0	0	0	0	0	0	0	0	0	0	0	0
Prime Target	All			None			None			None			None		
Major Technologies & Contribution to Economic Savings	Technology	% of Eco		Technology	% of Eco		Technology	% of Eco		Technology	% of Eco		Technology	% of Eco	
	ECPM Motor	100%													
Approx Svgs/Dwelling/suite		250													
Savings Adjustment Factor (if applicable)															
Approx. CCE (£/kWh)		5.0			0.0			0.0			0.0			0.0	
Approx. Customer Payback (yrs)		11.3			0.0			0.0			0.0			0.0	
Participation Rate (% of Eco svgs)	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	3	25	75												
Upper	5	45	90												
Action Savings, by Year (GWh)	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	0.8	14	70	0	0	0	0	0	0	0	0	0	0	0	0
Upper	1	25	85	0	0	0	0	0	0	0	0	0	0	0	0
Total Savings, by Year (GWh)													05/06	10/11	15/16
													0.8	14	70
Most Likely													1	25	85
Upper															

Note Savings per unit is based on an assumed mixture of some homes fan running only when heating and others with continuous ventilation.

Action Profile R 6 – High Performance Heat Pumps

Overview:

This Action will promote the installation of high performance cold climate heat pumps in new electrically heated single family and duplex homes.

The broad strategy envisioned for this Action consists of:

- strong up-front promotional efforts directed towards customers, vendors and trade allies
- financial incentives targeted to both customers and vendors for the first 5 years to boost market momentum
- a BCH exit strategy that involves accelerated changes to provincial regulations affecting the minimum energy performance of air conditioning equipment and heat pumps.

Target Technologies and Sub Segments:

- Cold climate heat pumps – new SFD/Duplex

Target Stakeholder Group:

- Homeowners
- Homeowners who are contemplating a renovation on their home
- Building owners who pay for operating expenditures
- Housing authorities that subsidize operating costs of building occupants
- Vendors and trade allies

Key Barriers and Interventions:

Experience to date indicates that the most significant barriers affecting this opportunity are:

- Lack of customer awareness
- Product availability
- Capital cost
- Perceived risk re: uncertainty of performance

This Action will address these barriers by combining the following interventions:

- Promotion and awareness
- Technical information
- Financial incentives such as on the spot financing for individuals who own their own homes will be provided for the first 5 years.

Time Frame:

Start in 2003; financial incentives to 2008; standards and labeling initiatives post 2008.

Relationship to Other Actions:

This Action complements activities envisioned under Actions R5. This measure could be integrated with the energy star rating as heat pumps are included.

Action Profile R 6 – High Performance Heat Pumps

Overview:

This Action will promote the installation of high performance cold climate heat pumps in new electrically heated single family and duplex homes.

The broad strategy envisioned for this Action consists of:

- strong up-front promotional efforts directed towards customers, vendors and trade allies
- financial incentives targeted to both customers and vendors for the first 5 years to boost market momentum
- a BCH exit strategy that involves accelerated changes to provincial regulations affecting the minimum energy performance of air conditioning equipment and heat pumps.

Target Technologies and Sub Segments:

- Cold climate heat pumps – new SFD/Duplex

Target Stakeholder Group:

- Homeowners
- Homeowners who are contemplating a renovation on their home
- Building owners who pay for operating expenditures
- Housing authorities that subsidize operating costs of building occupants
- Vendors and trade allies

Key Barriers and Interventions:

Experience to date indicates that the most significant barriers affecting this opportunity are:

- Lack of customer awareness
- Product availability
- Capital cost
- Perceived risk re: uncertainty of performance

This Action will address these barriers by combining the following interventions:

- Promotion and awareness
- Technical information
- Financial incentives such as on the spot financing for individuals who own their own homes will be provided for the first 5 years.

Time Frame:

Start in 2003; financial incentives to 2008; standards and labeling initiatives post 2008.

Relationship to Other Actions:

This Action complements activities envisioned under Actions R5. This measure could be integrated with the energy star rating as heat pumps are included.

Residential Sector - Action R6 - Energy Star High Performance Heat Pumps

Sub Sector	SFD/Duplex				Low-rise			Row			Mobile/Other			High-rise		
Approx % of Action Savings	100%				0%			0%			0%			0%		
Eco Savings (GWh) to 2015/16	05/06	10/11	15/16		05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
	38	91	149		0	0	0	0	0	0	0	0	0	0	0	0
Participant Definition	Dwellings				None			None			None			None		
Total Applicable Dwellings ('000s)	6	9	9		0	0	0	0	0	0	0	0	0	0	0	0
Prime Target	New, electrically-heated dwellings				None			None			None			None		
Major Technologies & Contribution to Economic Savings	Technology	% of Eco		% of Eco	Technology	% of Eco		% of Eco	Technology	% of Eco		% of Eco	Technology	% of Eco		
	Heat Pump	100%														
Approx Svgs/Dwelling/suite	6,291															
Savings Adjustment Factor (if applicable)	Deal with these as per commercial															
Approx. CCE (\$/kWh)	5.9	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		
Approx. Customer Payback (yrs)	9.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		
Participation Rate (% of Eco svgs)	05/06	10/11	15/16		05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
	Most Likely	2	3	4												
Upper	4	6	8													
Action Savings, by Year (GWh)	05/06	10/11	15/16		05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
	Most Likely	1	3	6	0	0	0	0	0	0	0	0	0	0	0	0
Upper	2	5	12	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Savings, by Year (GWh)																
Most Likely																
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Action Profile R 7 - Comprehensive Weatherization

Overview:

This Action will encourage customers to reduce space heating energy use in their existing homes and apartments by promoting the installation of crawl space insulation, air sealing, high performance windows and programmable set back thermostats. Promotion of retrofit activities and, in particular, purchase of high performance windows will "piggy back" consumer renovation activity. It will also promote improved thermal performance in new homes.

The broad strategy envisioned for this Action consists of:

- strong up-front promotional efforts directed towards customers, vendors and trade allies
- an initial energy audit using Energuide for Houses auditors and evaluations. The evaluations may be offered free of charge for those customers that proceed with a minimum level of retrofits. Additional data could be collected at this time to identify significant non envelope energy opportunities.
- provision of pre-qualified home retrofit contractors, quality assurance of retrofit installations. A post retrofit evaluation may also be included to establish or confirm savings.
- financial incentives in the form of customer rebates for the purchase of high performance windows.
- a BCH exit strategy that involves accelerated changes to provincial regulations affecting the minimum energy performance of windows; this may be further supported through increased coverage of the Energuide house labelling initiative.

Target Technologies and Sub Segments:

- Window upgrades – SFD/Duplex and row
- Envelope (Air Sealing, crawl space insulation) and thermostat set back - SFD/Duplex, row and mobile
- Thermostat set back – Apartment

Target Stakeholder Group:

- Homeowners
- Homeowners who are contemplating a renovation on their home
- Building owners who pay for operating expenditures
- Housing authorities that subsidize operating costs of building occupants
- Vendors and trade allies

Key Barriers and Interventions:

Experience to date indicates that the most significant barriers to comprehensive weatherization are:

- Lack of customer EE awareness – e.g., improved comfort and re-sale value of the home
- Access to financing
- Perceived risk/reward – e.g., confidence in the assessment of required investment and payback; confidence in contractor qualifications

This Action will address these barriers by combining the following interventions:

- Information and promotion – e.g., promotion of benefits; building labeling through provision of an Energuide certificate
- Technical services – e.g., information on the energy efficiency of the dwelling and upgrade opportunities, third party verification
- Vendor-customer links – e.g., contractor certification and quality assurance of the audit (through Energuide)
- Financial incentives – e.g., low interest loans or customer rebates for high performance windows

Time Frame:

Start in 2003; financial incentives to 2008; standards and labeling initiatives post 2008.

Relationship to Other Actions:

This Action complements activities envisioned under Actions R4, R5 and R7.

Action Profile R 7 - Comprehensive Weatherization

Overview:

This Action will encourage customers to reduce space heating energy use in their existing homes and apartments by promoting the installation of crawl space insulation, air sealing, high performance windows and programmable set back thermostats. Promotion of retrofit activities and, in particular, purchase of high performance windows will "piggy back" consumer renovation activity. It will also promote improved thermal performance in new homes.

The broad strategy envisioned for this Action consists of:

- strong up-front promotional efforts directed towards customers, vendors and trade allies
- an initial energy audit using Energuide for Houses auditors and evaluations. The evaluations may be offered free of charge for those customers that proceed with a minimum level of retrofits. Additional data could be collected at this time to identify significant non envelope energy opportunities.
- provision of pre-qualified home retrofit contractors, quality assurance of retrofit installations. A post retrofit evaluation may also be included to establish or confirm savings.
- financial incentives in the form of customer rebates for the purchase of high performance windows.
- a BCH exit strategy that involves accelerated changes to provincial regulations affecting the minimum energy performance of windows; this may be further supported through increased coverage of the Energuide house labelling initiative.

Target Technologies and Sub Segments:

- Window upgrades - SFD/Duplex and row
- Envelope (Air Sealing, crawl space insulation) and thermostat set back - SFD/Duplex, row and mobile
- Thermostat set back - Apartment

Target Stakeholder Group:

- Homeowners
- Homeowners who are contemplating a renovation on their home
- Building owners who pay for operating expenditures
- Housing authorities that subsidize operating costs of building occupants
- Vendors and trade allies

Key Barriers and Interventions:

Experience to date indicates that the most significant barriers to comprehensive weatherization are:

- Lack of customer EE awareness - e.g., improved comfort and re-sale value of the home
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- Vendor-customer links - e.g., contractor certification and quality assurance of the audit (through Energuide)
- Financial incentives - e.g., low interest loans or customer rebates for high performance windows

Time Frame:

Start in 2003; financial incentives to 2008; standards and labeling initiatives post 2008.

Relationship to Other Actions:

This Action complements activities envisioned under Actions R4, R5 and R7.

Residential Sector - Action R7 - Comprehensive Weatherization

Sub Sector	SFD/Duplex			Low-rise			Row			Mobile/Other			High-rise		
Approx % of Action Savings	57%			25%			7%			1%			10%		
Eco Savings (GWh) to 2015/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
	60	118	170	71	71	71	8	15	21	1	2	3	29	29	29
Participant Definition	Dwellings			Dwellings			Dwellings			Dwellings			Dwellings		
Total Applicable Dwellings ('000s)	67	60	54	127	0	0	8	8	8	2	2	2	52	0	0
Prime Target	Existing, electrically-heated			Existing, electrically-heated			Existing, electrically-heated			Existing, electrically-heated			Existing, electrically-heated		
Major Technologies & Contribution to Economic Savings	Technology		% of Eco	Technology		% of Eco	Technology		% of Eco	Technology		% of Eco	Technology		% of Eco
	Windows		45%	Thermostat		100%	Windows		50%	Windows		80%	Thermostat		100%
	Envelope		35%				Envelope		35%	Thermostat		20%			
	Thermostat		20%				Thermostat		15%						
Approx Svgs/Dwelling/suite	3,122			560			2,595			1,876			560		
Savings Adjustment Factor (if applicable)															
Approx. CCE (¢/kWh)	2.9			3.0			3.7			5.5			3		
Approx. Customer Payback (yrs)	8.5			6.9			9.4			7.0			6.9		
Participation Rate (% of Eco svgs)	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
	4	8	25	3	0	0	3	6	19	3	6	19	3	0	0
Most Likely Upper	8	25	33	5	0	0	6	19	25	6	19	25	5	0	0
Action Savings, by Year (GWh)	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely Upper	2	9	42	2	0	0	0	1	4	0.0	0	1	1	0	0
	5	29	56	4	0	0	0	3	5	0.1	0	1	2	0	0
Total Savings, by Year (GWh)													05/06	10/11	15/16
													5	10	47
													11	33	62

Action Profile R 8 – Standby Losses

Goal:

This Action addresses standby losses in a wide range of household electronic equipment that consumes electricity in standby mode. No specific modelling of the savings potential was undertaken.

Potential standby savings are based on the work of Lawrence Berkeley Labs; it is assumed that over the study period certifications such as Energy Star will help to identify products that have reduced standby losses and that Power Smart promotion of those qualifying products will lead to electricity savings.

Target Technologies and Sub Segments:

Target Stakeholder Group:

Key Barriers and Interventions:

Time Frame:

Relationship to Other Actions:

Action Profile R 8 – Standby Losses

Goal:

This Action addresses standby losses in a wide range of household electronic equipment that consumes electricity in standby mode. No specific modelling of the savings potential was undertaken.

Potential standby savings are based on the work of Lawrence Berkeley Labs; it is assumed that over the study period certifications such as Energy Star will help to identify products that have reduced standby losses and that Power Smart promotion of those qualifying products will lead to electricity savings.

Target Technologies and Sub Segments:

Target Stakeholder Group:

Key Barriers and Interventions:

Time Frame:

Relationship to Other Actions:

Sub Sector	SFD/Duplex			Low-rise			Row			Mobile/Other			High-rise		
Approx % of Action Savings	73%			8%			6%			9%			3%		
Eco Savings (GWh) to 2015/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
	112	226	342	12	24	36	10	20	30	14	28	42	5	11	16
Participant Definition	Dwellings			Dwellings			Dwellings			Dwellings			Dwellings		
Total Applicable Dwellings ('000s)	339	348	353	132	135	136	52	54	54	43	43	44	59	61	62
Prime Target	All			All			All			All			All		
Major Technologies & Contribution to Economic Savings	% of Eco			% of Eco			% of Eco			% of Eco			% of Eco		
	Technology			Technology			Technology			Technology			Technology		
	Standby Losses			Standby Losses			Standby Losses			Standby Losses			Standby Losses		
	100%			100%			100%			100%			100%		
Approx	329			89			188			322			88		
Svgs/Dwelling/suite															
Savings Adjustment Factor (if applicable)															
Approx. CCE (£/kWh)	N/A			N/A			N/A			N/A			N/A		
Approx. Customer Payback (yrs)	N/A			N/A			N/A			N/A			N/A		
Participation Rate (% of Eco svgs)	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	0	5	10	0	5	10	0	5	10	0	5	10	0	5	10
Upper	2	10	20	2	10	20	2	10	20	2	10	20	2	10	20
Action Savings, by Year (GWh)	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16	05/06	10/11	15/16
Most Likely	0.0	11	34	0.0	1	4	0.0	1	3	0.0	1	4	0.0	1	2
Upper	2.2	23	68	0.2	2	7	0.2	2	6	0.3	3	8	0.1	1	3
Total Savings, by Year (GWh)													05/06	10/11	15/16
													0.0	15	47
													3.0	31	93

ATTACHMENT A

**Previous Power Smart
Program Results**

- Residential Sector -

Power Smart Participation

	1999/00	1998/99	1997/98	1996/97	1995/96	1994/95	1993/94	1992/93	1991/92	1990/91	Prior	Total
(YTD 06/00)												
51	298	3018	2852	2,466	2,944	6,314	1,865	3,601	2,490	228	0	26,076
N/A	N/A	N/A	N/A	N/A	N/A	N/A	16,000	N/A	N/A	N/A	N/A	16,000
0	0	0	0	0	0	0	0	33,591	53,346	40,944	12,653	140,534
N/A	1918	6166	8413	16,405	18,752	41,504	29,240	22,855	10,806	5,503	0	161,562
N/A	N/A	N/A	N/A	N/A	N/A	3,374	7,434	6,291	4,825	3,950	3,118	28,992
N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	4,742	5,016	4,509	1,513	15,780
N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	36,829	5,600	0	42,429
N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	29,230	32,500	61,730
N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	50,800	0	0	50,800
N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	72	86	8	166
0	8	16	25	36	51	54	85	100	106	191	447	1,119
N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	52	0	52
N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	0	17,073	17,073
N/A	230	1104	1240	783	5,808	61						9,226
N/A	N/A	N/A	N/A	23,153	78,995							102,148
N/A	N/A	N/A	N/A	0	904	6,561						7,465
N/A	N/A	N/A	N/A	0	N/A	4,781						4,781
51	2,454	10,304	12,530	42,843	107,454	62,649	54,624	71,180	164,290	90,293	67,312	685,933

Programs

Residential:

Home Improvements
 Home Energy Savers
 Refrigerator Efficiency
 Refrigerator Recovery
 Electric to Gas W.H.
 Pwr Smart W.H. Ph 1
 Hot Water Saver
 Water Heater Blanket
 Residential Lighting
 Quality Plus Homes
 Non-Integrated Areas
 Residential Fuel of Choice
 Home Check-Up
 Pwr Smt New Homes
 BC 21
 Energy Education
 Retail Promotion
Total Residential

Power Smart Participation

2000/01 1999/00 1998/99 1997/98 1996/97 1995/96 1994/95 1993/94 1992/93 1991/92 1990/91 Prior Total
(YTD 06/00)

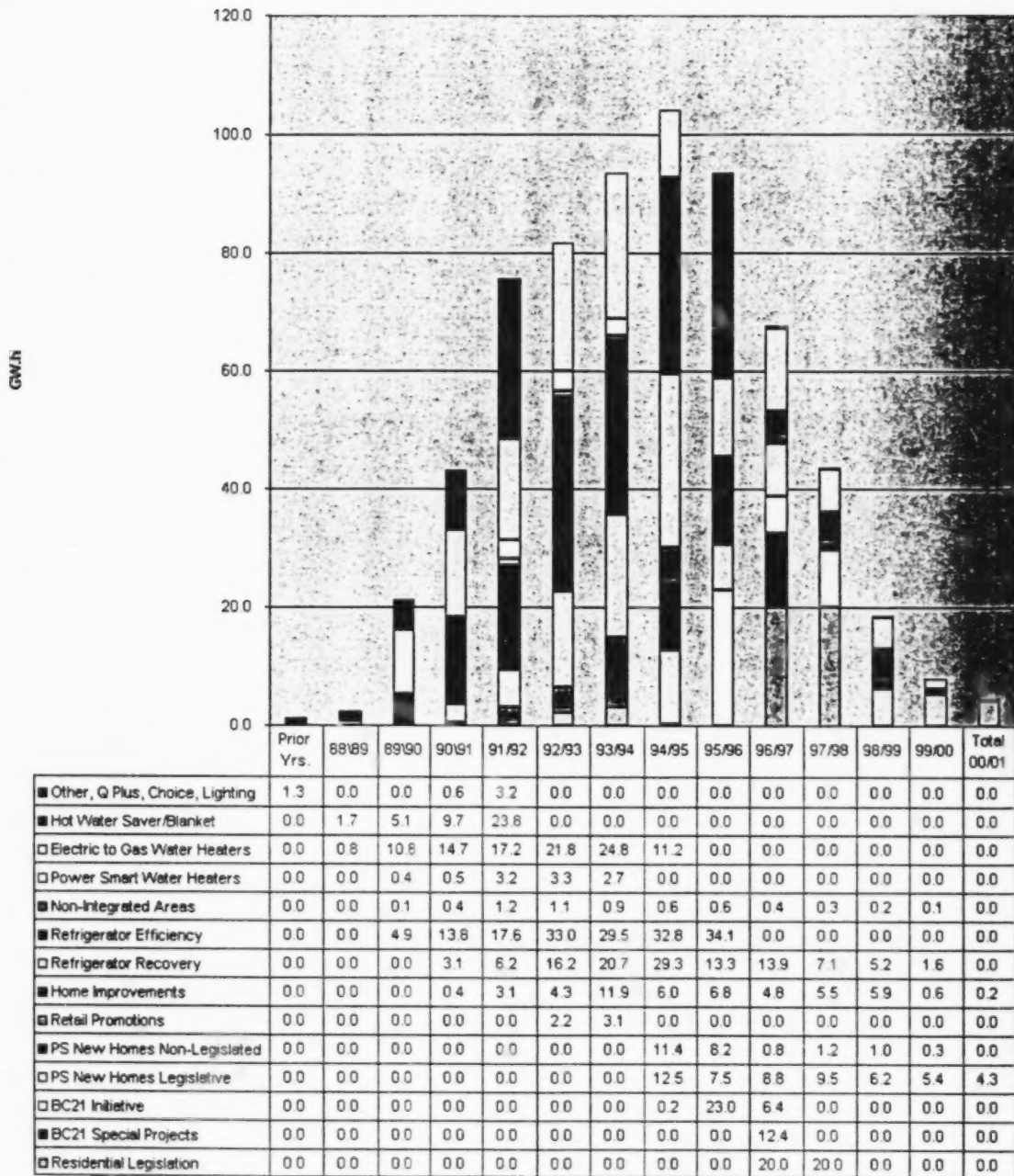
Programs

Residential:

Home Improvements
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Residential Lighting
Quality Plus Homes
Non-Integrated Areas
Residential Fuel of Choice
Home Check-Up
Pwr Smt New Homes
BC 21
Energy Education
Retail Promotion
Total Residential

51	298	3018	2852	2,466	2,944	6,314	1,865	3,601	2,400	228	0	26,076
N/A	N/A	N/A	N/A	N/A	N/A	N/A	16,000	N/A	N/A	N/A	N/A	16,000
0	0	0	0	0	0	0	0	33,591	53,346	40,944	12,653	140,534
N/A	1918	6166	8413	16,405	18,752	41,504	29,240	22,855	10,806	5,503	0	161,562
N/A	N/A	N/A	N/A	N/A	N/A	3,374	7,434	6,291	4,825	3,950	3,118	28,992
N/A	N/A	N/A	N/A	N/A	N/A		0	4,742	5,016	4,509	1,513	15,780
N/A	N/A	N/A	N/A	N/A	N/A		0	0	36,829	5,600	0	42,429
N/A	N/A	N/A	N/A	N/A	N/A		0	0	0	29,230	32,500	61,730
N/A	N/A	N/A	N/A	N/A	N/A		0	0	50,800	0	0	50,800
N/A	N/A	N/A	N/A	N/A	N/A		0	0	72	86	8	166
0	8	16	25	36	51	54	85	100	106	191	447	1,119
N/A	N/A	N/A	N/A	N/A	N/A		0	0	0	52	0	52
N/A	N/A	N/A	N/A	N/A	N/A		0	0	0	0	0	17,073
N/A	230	1104	1240	783	5,808	61						9,226
N/A	N/A	N/A	N/A	23,153	78,995							102,148
N/A	N/A	N/A	N/A	0	904	6,561						7,465
N/A	N/A	N/A	N/A	0	N/A	4,781						4,781
51	2,454	10,304	12,530	42,843	107,454	62,649	54,524	71,180	164,290	90,293	67,312	685,933

Residential Power Smart (GWh)



Savings by Year

Power Smart Annual Incremental Savings - Inception to 03/01

1991 = \$1.00 million = 12%
1,000,000

	Prior Yrs.	86/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	Total 00/01	Total
Residential															
Residential Natural Choice (see Com.)	—	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0
Power Smart Water Heaters	—	0	380,000	450,000	3,160,000	3,260,000	2,740,000	0	0	0	0	0	0	0	3,990,000
Refrigerator Efficiency	—	0	4,910,000	13,820,000	17,580,000	32,970,000	29,540,000	32,799,999	34,081,200	0	0	0	0	0	165,701,203
Residential Legislation															
Electric To Gas Water Heaters	—	800,000	10,800,000	14,700,000	17,200,000	21,800,000	24,760,710	11,224,518	0	20,004,000	20,004,000	0	N/A	0	101,293,228
Home Improvements	—	0	0	440,000	3,140,000	4,270,000	11,886,768	6,963,974	6,773,670	4,786,686	8,638,698	6,860,972	578,717	246,000	49,489,676
Refrigerator Recovery (Buy-Back)	—	0	0	3,140,870	6,193,082	16,161,766	20,674,154	29,346,817	13,258,602	13,893,066	7,100,000	6,222,856	1,624,316	0	116,624,628
Energy Efficient Lighting (Misc)	—	0	0	0	3,065,748	0	N/A	N/A	N/A	N/A	N/A	N/A	0	0	3,065,748
PS New Homes Non-Legislated	—	0	0	0	0	0	0	11,379,487	0	0	1,177,601	1,011,478	296,393	0	22,912,630
PS New Homes Legislated	—	0	0	0	0	0	0	12,644,809	7,548,895	8,849,360	9,615,047	6,180,942	5,412,446	4,297,578	54,349,077
Non-Integrated Areas															
BC21 Initiative	—	0	61,772	387,144	1,238,337	1,081,601	907,120	678,288	576,288	584,182	268,800	170,762	85,876	21,344	5,743,084
BC21 Initiative - Special Projects	—	N/A	N/A	N/A	N/A	N/A	N/A	227,808	23,010,980	6,436,344	N/A	N/A	0	0	29,665,232
Hot Water Solar/Water Heater Banket (Misc)	—	1,666,000	5,061,160	9,676,610	23,846,778	N/A	N/A	N/A	N/A	12,436,667	N/A	N/A	0	0	12,436,667
Quality Plus Homes	—	0	27,768	122,820	150,533	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	301,109
Res Fuel of Choice	—	0	0	468,000	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	468,000
Retail Promotions	—	N/A	N/A	N/A	N/A	2,163,343	3,090,370	N/A	N/A	N/A	N/A	N/A	0	0	6,243,713
Other	1,266,480	—	—	—	—	—	—	—	—	—	—	—	—	—	1,266,480
Total	1,266,480	2,468,000	21,230,878	43,214,444	76,574,478	81,898,789	93,509,118	104,083,760	93,481,267	87,698,834	43,601,947	18,447,000	7,987,217	4,584,922	658,802,720



APPENDIX D

➤ Derivation of Demand Impacts

Table of Contents

Reference Case – Lower Mainland

Economic Potential Forecast – Lower Mainland

Reference Case – Vancouver Island

Economic Potential Forecast – Vancouver Island

Reference Case – Interior

Economic Potential Forecast – Interior

Reference Case – Total

Economic Potential Forecast – Total

SEEM: Marbek's Sector Energy End-use Model--Capacity

Reference Case - Lower Mainland

Enduse	Annual Energy Distribution				Annual Energy Use (Gwh)-Ref. Case				Average Demand in Winter Peak (MW)			
	Winter Peak	Winter Off-Peak	Shoulder	Total (check)	2001	2006	2011	2016	2001	2006	2011	2016
SFD/Duplex												
Heating	11%	19%	70%	100%	856	917	987	1,067	146	157	169	182
Vent.	11%	19%	70%	100%	223	244	267	293	38	42	46	50
DHW	13%	8%	79%	100%	202	210	221	233	39	40	42	45
Cook.	11%	7%	82%	100%	283	301	322	345	47	50	54	58
Refrig.	8%	9%	83%	100%	509	470	445	431	65	60	57	55
Freezer	8%	9%	82%	100%	253	219	181	162	32	28	23	21
Dish.	11%	7%	82%	100%	35	36	37	39	6	6	6	7
Washer	14%	5%	81%	100%	33	32	32	33	7	7	7	7
Dryer	12%	6%	82%	100%	380	388	398	415	69	70	72	75
Micro.	13%	7%	81%	100%	75	80	86	93	14	16	17	18
Computer	10%	7%	83%	100%	60	74	85	101	9	11	13	16
Light	15%	10%	75%	100%	798	847	904	968	181	192	205	220
Colour TV	10%	7%	83%	100%	445	478	515	557	69	74	79	86
Other	10%	7%	83%	100%	919	986	1,063	1,149	142	152	164	177
Total					5,071	5,282	5,544	5,888	865	905	954	1,016
Row Unit												
Heating	11%	19%	70%	100%	127	141	156	174	22	24	27	30
Vent.	11%	19%	70%	100%	18	24	30	37	3	4	5	6
DHW	13%	8%	79%	100%	61	64	68	72	12	12	13	14
Cook.	11%	7%	82%	100%	46	52	60	69	8	9	10	11
Refrig.	8%	9%	83%	100%	80	79	80	84	10	10	10	11
Freezer	8%	9%	82%	100%	29	26	23	23	4	3	3	3
Dish.	11%	7%	82%	100%	5	5	6	7	1	1	1	1
Washer	14%	5%	81%	100%	4	4	5	5	1	1	1	1
Dryer	12%	6%	82%	100%	59	63	70	78	11	12	13	14
Micro.	13%	7%	81%	100%	13	15	18	21	3	3	3	4
Computer	10%	7%	83%	100%	9	12	15	19	1	2	2	3
Light	15%	10%	75%	100%	110	127	146	170	25	29	33	39
Colour TV	10%	7%	83%	100%	71	82	95	110	11	13	15	17
Other	10%	7%	83%	100%	114	131	152	176	18	20	23	27
Total					746	826	924	1,046	128	142	160	181
Low Rise Apartment												
Heating	11%	19%	70%	100%	167	185	205	227	29	32	35	39
Vent.	11%	19%	70%	100%	61	68	77	87	10	12	13	15
DHW	13%	8%	79%	100%	40	43	46	50	8	8	9	10
Cook.	11%	7%	82%	100%	79	87	98	109	13	15	16	18
Refrig.	8%	9%	83%	100%	126	122	123	125	16	16	16	16
Freezer	8%	9%	82%	100%	6	6	9	10	1	1	1	1
Dish.	11%	7%	82%	100%	6	6	7	9	1	1	1	1
Washer	14%	5%	81%	100%	5	5	5	5	1	1	1	1
Dryer	12%	6%	82%	100%	51	54	58	63	9	10	10	11
Micro.	13%	7%	81%	100%	33	37	42	47	6	7	8	9
Computer	10%	7%	83%	100%	16	21	25	31	3	3	4	5
Light	15%	10%	75%	100%	413	459	512	570	94	104	116	129
Colour TV	10%	7%	83%	100%	102	115	129	145	16	18	20	22
Other	10%	7%	83%	100%	100	112	126	142	15	17	19	22
Total					1,204	1,324	1,461	1,618	222	244	270	300

SEEM: Marbek's Sector Energy End-use Model--Capacity

Reference Case - Lower Mainland

Enduse	Annual Energy Distribution				Annual Energy Use (Gwh)--Ref. Case				Average Demand in Winter Peak (MW)			
	Winter Peak	Winter Off-Peak	Shoulder	Total (check)	2001	2006	2011	2016	2001	2006	2011	2016
High Rise Apartment												
Heating	11%	19%	70%	100%	99	111	124	138	17	19	21	24
Vent.	11%	19%	70%	100%	34	38	43	48	6	6	7	8
DHW	13%	8%	79%	100%	20	22	23	25	4	4	4	5
Cook.	11%	7%	82%	100%	39	44	49	55	7	7	8	9
Refrig.	8%	9%	83%	100%	63	61	62	63	8	8	8	8
Freezer	8%	9%	82%	100%	6	6	7	7	1	1	1	1
Dish.	11%	7%	82%	100%	3	3	4	4	0	1	1	1
Washer	14%	5%	81%	100%	2	2	2	3	0	0	1	1
Dryer	12%	6%	82%	100%	25	27	29	32	5	5	5	6
Micro.	13%	7%	81%	100%	17	19	21	24	3	4	4	5
Computer	10%	7%	83%	100%	8	11	13	16	1	2	2	2
Light	15%	10%	75%	100%	269	299	333	371	61	68	76	84
ColourTV	10%	7%	83%	100%	65	73	82	93	10	11	13	14
Other	10%	7%	83%	100%	80	90	101	114	12	14	16	18
Total					730	806	893	992	135	150	166	185
Mobile/Other												
Heating	11%	19%	70%	100%	79	84	89	95	14	14	15	16
Vent.	11%	19%	70%	100%	5	6	6	7	1	1	1	1
DHW	13%	8%	79%	100%	51	54	56	60	10	10	11	11
Cook.	11%	7%	82%	100%	15	15	16	18	2	3	3	3
Refrig.	8%	9%	83%	100%	25	23	22	21	3	3	3	3
Freezer	8%	9%	82%	100%	9	8	7	6	1	1	1	1
Dish.	11%	7%	82%	100%	1	1	1	1	0	0	0	0
Washer	14%	5%	81%	100%	1	1	1	1	0	0	0	0
Dryer	12%	6%	82%	100%	16	16	16	17	3	3	3	3
Micro	13%	7%	81%	100%	4	5	5	5	1	1	1	1
Computer	10%	7%	83%	100%	1	1	2	2	0	0	0	0
Light	15%	10%	75%	100%	25	27	28	30	6	6	6	7
ColourTV	10%	7%	83%	100%	23	24	26	28	3	4	4	4
Other	10%	7%	83%	100%	74	79	85	92	11	12	13	14
Total					330	344	362	383	56	59	62	65
Total					1,329	1,437	1,561	1,702	227	246	267	291
Heating					341	379	423	472	58	65	72	81
Vent.					374	392	414	440	72	83	91	99
DHW					462	500	544	596	77	83	91	99
Cook.					803	755	731	723	103	97	94	93
Refrig.					305	267	227	209	39	34	29	27
Freezer					49	52	55	61	8	9	9	10
Dish.					46	45	46	47	9	9	9	10
Washer					531	549	571	605	96	100	104	110
Dryer					142	156	172	190	27	30	33	37
Micro.					95	119	140	169	15	18	22	26
Computer					1,614	1,759	1,924	2,109	366	399	437	479
Light					706	772	847	933	109	119	131	144
ColourTV					1,266	1,399	1,527	1,673	199	216	236	258
Other					8,081	8,582	9,183	9,926	1,406	1,501	1,612	1,748

Enduse	Annual Energy Distribution			Total (check)	Annual Energy Use (Gwh)-Ref. Case					Average Demand in Winter Peak (MW)				
	Winter Peak	Winter Off-Peak	Shoulder		2001	2006	2011	2016	2001	2006	2011	2016		
SFD/Duplex														
Heating	11%	19%	70%	100%	856	912	977	1,052		146	156	167	180	
Vent.	11%	19%	70%	100%	223	228	233	237		38	39	40	40	
DHW	13%	8%	79%	100%	202	172	168	171		39	33	32	33	
Cook	11%	7%	82%	100%	283	301	322	345		47	50	54	58	
Refrig	8%	9%	83%	100%	509	400	327	281		65	51	42	36	
Freezer	8%	9%	82%	100%	253	276	158	130		32	26	20	17	
Dish	11%	7%	82%	100%	35	35	35	36		6	6	6	6	
Washer	14%	5%	81%	100%	33	29	26	21		7	6	5	4	
Dryer	12%	6%	82%	100%	380	388	398	415		69	70	72	75	
Micro	13%	7%	81%	100%	75	80	86	93		14	16	17	18	
Computer	10%	7%	83%	100%	60	35	40	47		9	5	6	7	
Light	15%	10%	75%	100%	798	415	447	483		181	94	102	110	
ColourTV	10%	7%	83%	100%	445	445	447	451		69	69	69	70	
Other	10%	7%	83%	100%	919	928	947	977		142	143	146	151	
0	0%	0%	100%	100%										
Total					5,071	4,574	4,612	4,740		865	765	778	804	
Row Unit														
Heating	11%	19%	70%	100%	127	135	146	160		22	23	25	27	
Vent.	11%	19%	70%	100%	18	24	30	37		3	4	5	6	
DHW	13%	8%	79%	100%	61	53	53	54		12	10	10	10	
Cook	11%	7%	82%	100%	46	52	60	69		8	9	10	11	
Refrig	8%	9%	83%	100%	80	66	58	55		10	8	7	7	
Freezer	8%	9%	82%	100%	29	25	20	18		4	3	3	2	
Dish	11%	7%	82%	100%	5	5	5	6		1	1	1	1	
Washer	14%	5%	81%	100%	4	4	4	3		1	1	1	1	
Dryer	12%	6%	82%	100%	59	63	70	78		11	12	13	14	
Micro	13%	7%	81%	100%	13	15	18	21		3	3	3	4	
Computer	10%	7%	83%	100%	9	6	7	9		1	1	1	1	
Light	15%	10%	75%	100%	110	60	69	81		25	14	16	18	
ColourTV	10%	7%	83%	100%	71	77	83	89		11	12	13	14	
Other	10%	7%	83%	100%	114	123	135	150		18	19	21	23	
0	0%	0%	100%	100%										
Total					746	708	757	829		128	119	128	141	
Low Rise Apartment														
Heating	11%	19%	70%	100%	167	182	196	212		29	31	33	36	
Vent.	11%	19%	70%	100%	61	68	77	87		10	12	13	15	
DHW	13%	8%	79%	100%	40	36	36	37		8	7	7	7	
Cook	11%	7%	82%	100%	79	87	98	109		13	15	16	18	
Refrig	8%	9%	83%	100%	126	115	108	105		16	15	14	13	
Freezer	8%	9%	82%	100%	8	8	8	8		1	1	1	1	
Dish	11%	7%	82%	100%	6	6	7	8		1	1	1	1	
Washer	14%	5%	81%	100%	5	4	4	3		1	1	1	1	
Dryer	12%	6%	82%	100%	51	54	58	63		9	10	10	11	
Micro	13%	7%	81%	100%	33	37	42	47		6	7	8	9	
Computer	10%	7%	83%	100%	16	10	12	15		3	2	2	2	
Light	15%	10%	75%	100%	413	307	342	383		94	70	78	87	
ColourTV	10%	7%	83%	100%	102	107	112	118		16	17	17	18	
Other	10%	7%	83%	100%	100	105	112	121		15	16	17	19	
0	0%	0%	100%	100%										
Total					1,204	1,126	1,211	1,315		222	203	219	239	

Enduse	Annual Energy Distribution			Total (check)	Annual Energy Use (Gwh)-Ref. Case						Average Demand in Winter Peak (MW)					
	Winter Peak	Winter Off-Peak	Shoulder		2001	2006	2011	2016	2021	2026	2001	2006	2011	2016		
High Rise Apartment																
Heating	11%	19%	70%	100%	99	109	118	128			17	19	20			
Vent.	11%	19%	70%	100%	34	38	43	48			6	6	7			
DHW	13%	8%	79%	100%	20	18	18	19			4	3	3			
Cook	11%	7%	82%	100%	39	44	49	55			7	7	8			
Refrig.	8%	9%	83%	100%	63	58	54	53			8	7	7			
Freezer	8%	8%	82%	100%	6	6	6	6			1	1	1			
Dish	11%	7%	82%	100%	3	3	3	4			0	1	1			
Washer	14%	5%	81%	100%	2	2	2	2			0	0	0			
Dryer	12%	6%	82%	100%	25	27	29	32			5	5	5			
Micro	13%	7%	81%	100%	17	19	21	24			3	4	4			
Computer	10%	10%	83%	100%	8	5	6	7			1	1	1			
Light	15%	10%	75%	100%	269	207	231	258			61	47	52			
Colour TV	10%	7%	83%	100%	65	68	71	75			10	11	11			
Other	10%	7%	83%	100%	80	84	90	97			12	13	14			
0	0%	0%	100%	100%												
Total					730	687	741	806			135	125	135		148	
Mobile/Other																
Heating	11%	19%	70%	100%	79	84	89	95			14	14	15		16	
Vent.	11%	19%	70%	100%	5	6	6	7			1	1	1		1	
DHW	13%	8%	79%	100%	51	45	44	44			10	9	8		9	
Cook	11%	7%	82%	100%	15	15	16	18			2	3	3		3	
Refrig.	8%	9%	83%	100%	25	20	16	14			3	3	2		2	
Freezer	8%	9%	82%	100%	9	8	6	5			1	1	1		1	
Dish	11%	7%	82%	100%	1	1	1	1			0	0	0		0	
Washer	14%	5%	81%	100%	1	1	1	1			0	0	0		0	
Dryer	12%	6%	82%	100%	16	16	16	17			3	3	3		3	
Micro	13%	7%	81%	100%	4	5	5	5			1	1	1		1	
Computer	10%	10%	83%	100%	1	1	1	1			0	0	0		0	
Light	15%	10%	75%	100%	25	12	13	14			6	3	3		3	
Colour TV	10%	7%	83%	100%	23	23	23	23			3	3	3		3	
Other	10%	7%	83%	100%	74	75	76	78			11	12	12		12	
0	0%	0%	100%	100%												
Total					330	310	314	323			56	52	53		55	
Total																
Heating					1,329	1,421	1,526	1,647			227	243	261		282	
Vent.					341	364	389	416			58	62	66		71	
DHW					374	323	319	326			72	62	61		63	
Cook					462	500	544	596			77	83	91		99	
Refrig.					803	658	563	507			103	84	72		65	
Freezer					305	252	197	167			39	32	25		21	
Dish					49	50	52	55			8	8	9		9	
Washer					46	41	36	30			9	8	7		6	
Dryer					531	549	571	605			96	100	104		110	
Micro					142	156	172	190			27	30	33		37	
Computer					95	56	66	79			15	9	10		12	
Light					1,614	1,001	1,103	1,219			366	227	250		277	
Colour TV					706	720	736	755			109	111	114		117	
Other					1,286	1,315	1,360	1,422			199	203	210		219	
Grand Total					8,081	7,404	7,635	8,013			1,406	1,263	1,314		1,388	

SEEM: Marbek's Sector Energy End-use Model--Capacity

Reference Case - Vancouver Island

Enduse	Annual Energy Distribution			Total (check)	Annual Energy Use (Gwh)-Ref. Case			Average Demand in Winter Peak (MW)		
	Winter Peak	Winter Off-Peak	Shoulder		2001	2006	2011	2001	2006	2011
SFD/Duplex										
Heating	11%	17%	72%	100%	1,132	1,222	1,351	181	195	216
Vent.	11%	17%	72%	100%	62	71	81	10	11	13
DHW	13%	8%	79%	100%	396	421	455	76	81	87
Cook	11%	7%	82%	100%	117	126	139	20	21	23
Refrig.	8%	9%	83%	100%	220	206	201	199	28	26
Freezer	8%	9%	82%	100%	127	111	95	16	14	12
Dish.	11%	7%	82%	100%	11	13	14	2	2	2
Washer	14%	5%	81%	100%	12	12	13	3	3	3
Dryer	12%	6%	82%	100%	151	156	166	27	28	30
Micro.	13%	7%	81%	100%	34	37	41	7	7	8
Computer	10%	7%	83%	100%	23	28	34	4	4	5
Light	15%	10%	75%	100%	289	312	342	66	71	78
Colour TV	10%	7%	83%	100%	172	188	208	27	29	32
Other	10%	7%	83%	100%	406	443	505	63	68	78
Total					3,152	3,348	3,644	527	562	613
Row Unit										
Heating	11%	17%	72%	100%	38	41	45	6	7	7
Vent.	11%	17%	72%	100%	3	4	5	0	1	1
DHW	13%	8%	79%	100%	23	25	28	4	5	5
Cook	11%	7%	82%	100%	8	9	10	1	2	2
Refrig.	8%	9%	83%	100%	18	18	19	2	2	2
Freezer	8%	9%	82%	100%	8	7	6	1	1	1
Dish.	11%	7%	82%	100%	1	1	1	0	0	0
Washer	14%	5%	81%	100%	1	1	1	0	0	0
Dryer	12%	6%	82%	100%	10	11	12	2	2	2
Micro.	13%	7%	81%	100%	3	3	3	0	1	1
Computer	10%	7%	83%	100%	2	2	3	0	0	1
Light	15%	10%	75%	100%	19	22	24	4	5	6
Colour TV	10%	7%	83%	100%	14	16	18	2	2	3
Other	10%	7%	83%	100%	20	23	27	3	4	4
Total					167	183	202	25	31	34
Low Rise Apartment										
Heating	11%	17%	72%	100%	68	70	73	11	11	12
Vent.	11%	17%	72%	100%	18	19	21	3	3	3
DHW	13%	8%	79%	100%	33	34	36	6	7	7
Cook	11%	7%	82%	100%	19	20	22	3	3	4
Refrig.	8%	9%	83%	100%	35	33	32	4	4	4
Freezer	8%	9%	82%	100%	3	3	3	0	0	0
Dish.	11%	7%	82%	100%	1	1	2	0	0	0
Washer	14%	5%	81%	100%	1	1	1	0	0	0
Dryer	12%	6%	82%	100%	13	14	14	2	2	3
Micro.	13%	7%	81%	100%	9	10	11	2	2	2
Computer	10%	7%	83%	100%	5	6	7	1	1	1
Light	15%	10%	75%	100%	126	133	143	29	30	32
Colour TV	10%	7%	83%	100%	35	38	41	5	6	7
Other	10%	7%	83%	100%	31	33	36	5	5	6
Total					398	415	441	72	76	81

Reference Case - Vancouver Island

CSFEM: Marbek's Sector Energy End-use Model--Capacity

Enduse	Annual Energy Distribution			Total (check)	Annual Energy Use (Gwh)-Ref Case						Average Demand in Winter Peak (MW)					
	Winter Peak	Winter Off-Peak	Shoulder		2001			2016			2001			2016		
					2001	2006	2011	2016	2001	2006	2011	2016				
High Rise Apartment																
Heating	11%	17%	72%	100%	19	20	23	25	3	3	3	4	4			
Vent	11%	17%	72%	100%	6	7	8	9	1	1	1	1	1			
DHW	13%	8%	79%	100%	9	10	10	11	2	2	2	2	2			
Cook	11%	7%	82%	100%	6	7	7	8	1	1	1	1	1			
Refrig.	8%	9%	83%	100%	11	10	10	10	1	1	1	1	1			
Freezer	8%	9%	82%	100%	1	1	1	1	0	0	0	0	0			
Dish	11%	7%	82%	100%	0	0	1	1	0	0	0	0	0			
Washer	14%	5%	81%	100%	0	0	0	0	0	0	0	0	0			
Dryer	12%	6%	82%	100%	4	4	5	5	1	1	1	1	1			
Micro	13%	7%	81%	100%	3	3	3	4	1	1	1	1	1			
Computer	10%	7%	83%	100%	1	2	2	3	0	0	0	0	0			
Light	15%	10%	75%	100%	51	56	61	67	12	13	14	15	15			
Colour TV	10%	7%	83%	100%	11	12	14	15	2	2	2	2	2			
Other	10%	7%	83%	100%	13	14	16	18	2	2	2	2	2			
Total					137	148	162	177	25	27	27	30	33			
Mobile/Other																
Heating	11%	17%	72%	100%	53	56	60	65	8	9	10	10	10			
Vent	11%	17%	72%	100%	4	5	6	7	1	1	1	1	1			
DHW	13%	8%	79%	100%	49	51	55	59	9	10	11	11	11			
Cook	11%	7%	82%	100%	11	12	13	14	2	2	2	2	2			
Refrig.	8%	9%	83%	100%	26	24	23	22	3	3	3	3	3			
Freezer	8%	9%	82%	100%	16	14	11	10	2	2	2	1	1			
Dish	11%	7%	82%	100%	1	1	1	1	0	0	0	0	0			
Washer	14%	5%	81%	100%	2	1	1	2	0	0	0	0	0			
Dryer	12%	6%	82%	100%	18	19	20	21	3	3	3	4	4			
Micro	13%	7%	81%	100%	4	4	5	5	1	1	1	1	1			
Computer	10%	7%	83%	100%	2	2	3	3	0	0	0	0	0			
Light	15%	10%	75%	100%	21	22	24	26	5	5	5	6	6			
Colour TV	10%	7%	83%	100%	17	19	20	22	3	3	3	3	3			
Other	10%	7%	83%	100%	72	77	85	92	11	12	13	14	14			
Total					295	307	326	349	49	51	51	55	59			
Low Rise Apartment																
Heating					1,309	1,409	1,552	1,708	209	225	248	272	272			
Vent					94	106	120	136	15	17	19	22	22			
DHW					510	541	585	633	98	104	112	121	121			
Cook					162	174	191	209	27	29	32	35	35			
Refrig.					309	291	283	281	40	37	36	36	36			
Freezer					154	137	117	108	20	17	15	14	14			
Dish					14	16	18	21	2	3	3	3	3			
Washer					16	16	17	17	3	3	3	3	3			
Dryer					197	204	216	230	36	37	39	42	42			
Micro					52	57	63	70	10	11	12	13	13			
Computer					32	40	48	58	5	6	7	9	9			
Light					506	545	595	649	115	124	135	147	147			
Colour TV					250	273	302	334	39	42	47	52	52			
Other					543	591	668	745	84	91	103	115	115			
Grand Total					4,149	4,400	4,775	5,197	702	747	812	885	885			

Enduse	Annual Energy Distribution			Annual Energy Use (Gwh)-Ref. Case					Average Demand in Winter Peak (MW)			
	Winter Peak	Winter Off-Peak	Shoulder	Total (check)	2001	2006	2011	2016	2001	2006	2011	2016
SFD/Duplex												
Heating	11%	17%	72%	100%	1,132	1,147	1,184	1,233	181	183	189	197
Vent.	11%	17%	72%	100%	62	67	71	76	10	11	11	12
DHW	13%	8%	79%	100%	396	344	348	361	76	66	67	69
Cook.	11%	7%	82%	100%	117	126	139	152	20	23	23	25
Refrig.	8%	9%	83%	100%	220	176	148	129	28	23	19	17
Freezer	8%	9%	82%	100%	127	105	83	69	16	13	11	9
Dish.	11%	7%	82%	100%	11	12	13	14	2	2	2	2
Washer	14%	5%	81%	100%	12	11	10	9	3	2	2	2
Dryer	12%	6%	82%	100%	151	156	166	176	27	28	30	32
Micro.	13%	7%	81%	100%	34	37	41	45	7	7	8	9
Computer	10%	7%	83%	100%	23	13	16	19	3	2	2	3
Light	15%	10%	75%	100%	289	153	169	187	66	35	38	43
Colour TV	10%	7%	83%	100%	172	175	181	187	27	27	28	29
Other	10%	7%	83%	100%	406	417	450	480	63	64	69	74
0	0%	0%	100%	100%								
Total					3,152	2,939	3,018	3,138	527	485	500	522
Row Unit												
Heating	11%	17%	72%	100%	38	39	42	46	6	6	7	7
Vent.	11%	17%	72%	100%	3	4	5	6	0	1	1	1
DHW	13%	8%	79%	100%	23	21	22	24	4	4	4	5
Cook.	11%	7%	82%	100%	8	9	10	12	1	2	2	2
Refrig.	8%	9%	83%	100%	18	15	13	12	2	2	2	2
Freezer	8%	9%	82%	100%	8	7	5	5	1	1	1	1
Dish.	11%	7%	82%	100%	1	1	1	1	0	0	0	0
Washer	14%	5%	81%	100%	1	1	1	1	0	0	0	0
Dryer	12%	6%	82%	100%	10	11	12	14	2	2	2	2
Micro.	13%	7%	81%	100%	3	3	3	4	0	1	1	1
Computer	10%	7%	83%	100%	2	1	1	2	0	0	0	0
Light	15%	10%	75%	100%	19	10	12	13	4	2	3	3
Colour TV	10%	7%	83%	100%	14	15	16	17	2	2	2	2
Other	10%	7%	83%	100%	20	22	24	26	3	3	4	4
Total					167	158	167	183	28	26	28	31
Low Rise Apartment												
Heating	11%	17%	72%	100%	68	70	73	76	11	11	12	12
Vent.	11%	17%	72%	100%	18	19	21	22	3	3	3	4
DHW	13%	8%	79%	100%	33	29	28	28	6	5	5	5
Cook.	11%	7%	82%	100%	19	20	22	24	3	3	4	4
Refrig.	8%	9%	83%	100%	35	31	29	26	4	4	4	3
Freezer	8%	9%	82%	100%	3	3	3	3	0	0	0	0
Dish.	11%	7%	82%	100%	1	1	2	2	0	0	0	0
Washer	14%	5%	81%	100%	1	1	1	1	0	0	0	0
Dryer	12%	6%	82%	100%	13	14	14	15	2	2	3	3
Micro.	13%	7%	81%	100%	9	10	11	12	2	2	2	2
Computer	10%	7%	83%	100%	5	3	3	4	1	0	0	1
Light	15%	10%	75%	100%	125	91	98	105	29	21	22	24
Colour TV	10%	7%	83%	100%	35	35	36	36	5	5	5	6
Other	10%	7%	83%	100%	31	31	32	33	5	5	5	5
Total					398	358	371	387	72	64	66	69

Enduse	Annual Energy Distribution			Total (check)	Annual Energy Use (Gwh)-Ref. Case					Average Demand in Winter Peak (MW)				
	Winter Peak	Winter Off-Peak	Shoulder		2001	2006	2011	2016	2001	2006	2011	2016		
High Rise Apartment														
Heating	11%	17%	72%	100%	19	20	22	24	3	3	3	4		
Vent.	11%	17%	72%	100%	6	7	8	9	1	1	1	1		
DHW	13%	8%	79%	100%	9	8	8	8	2	2	2	2		
Cook.	11%	7%	82%	100%	6	7	7	8	1	1	1	1		
Refrig	8%	9%	83%	100%	11	10	9	9	1	1	1	1		
Freezer	8%	9%	82%	100%	1	1	1	1	0	0	0	0		
Dish.	11%	7%	82%	100%	0	0	1	1	0	0	0	0		
Washer	14%	5%	81%	100%	0	0	0	0	0	0	0	0		
Dryer	12%	6%	82%	100%	4	4	5	5	1	1	1	1		
Micro.	13%	7%	81%	100%	3	3	3	4	1	1	1	1		
Computer	10%	7%	83%	100%	1	1	1	1	0	0	0	0		
Light	15%	10%	75%	100%	51	39	43	47	12	9	10	11		
ColourTV	10%	7%	83%	100%	11	12	12	12	2	2	2	2		
Other	10%	7%	83%	100%	13	14	14	15	2	2	2	2		
Total					137	126	134	144	25	23	24	26		
Mobile/Other														
Heating	11%	17%	72%	100%	53	54	57	61	8	9	9	10		
Vent.	11%	17%	72%	100%	4	5	6	7	1	1	1	1		
DHW	13%	8%	79%	100%	49	43	43	44	9	8	8	9		
Cook.	11%	7%	82%	100%	11	12	13	14	2	2	2	2		
Refrig.	8%	9%	83%	100%	26	20	17	14	3	3	2	2		
Freezer	8%	9%	82%	100%	16	13	10	8	2	2	1	1		
Dish.	11%	7%	82%	100%	1	1	1	1	0	0	0	0		
Washer	14%	5%	81%	100%	2	1	1	1	0	0	0	0		
Dryer	12%	6%	82%	100%	18	19	20	21	3	3	4	4		
Micro.	13%	7%	81%	100%	4	4	5	5	1	1	1	1		
Computer	10%	7%	83%	100%	2	1	1	1	0	0	0	0		
Light	15%	10%	75%	100%	21	10	11	12	5	2	3	3		
ColourTV	10%	7%	83%	100%	17	17	18	18	3	3	3	3		
Other	10%	7%	83%	100%	72	73	75	78	11	11	12	12		
Total					295	274	278	286	49	45	46	47		
Total														
Heating					1,309	1,330	1,378	1,439	209	212	220	230		
Vent.					94	101	111	120	15	16	18	19		
DHW					510	444	449	466	98	85	86	90		
Cook.					162	174	191	209	27	29	32	35		
Refrig.					309	252	214	191	40	32	27	24		
Freezer					154	129	102	86	20	17	13	11		
Dish.					14	15	17	19	2	3	3	3		
Washer					16	15	13	11	3	3	3	2		
Dryer					197	204	216	230	36	37	39	42		
Micro.					52	57	63	70	10	11	12	13		
Computer					32	19	22	27	5	3	3	4		
Light					506	304	333	366	115	69	76	83		
ColourTV					250	254	262	270	39	39	40	42		
Other					543	557	596	633	84	86	92	98		
Grand Total					4,149	3,856	3,968	4,138	702	642	665	696		

SEEM: Marbek's Sector Energy End-use Model--Capacity

Reference Case - Interior

Enduse	Annual Energy Distribution			Total (check)	Annual Energy Use (Gwh)-Ref. Case			Average Demand in Winter Peak (MW)		
	Winter Peak	Winter Off-Peak	Shoulder		2001	2006	2011	2001	2006	2011
SFD/Duplex										
Heating	14%	22%	64%	100%	426	463	503	87	95	103
Vent	14%	22%	64%	100%	86	96	106	18	20	22
DHW	13%	8%	79%	100%	174	185	198	33	36	38
Cook	11%	7%	82%	100%	102	111	122	17	19	20
Refrig	8%	9%	83%	100%	223	212	206	29	27	26
Freezer	8%	9%	82%	100%	146	130	110	19	17	14
Dish	11%	7%	82%	100%	11	12	13	2	2	2
Washer	14%	5%	81%	100%	12	12	12	2	2	2
Dryer	12%	6%	82%	100%	142	149	157	26	27	29
Micro	13%	7%	81%	100%	33	36	40	6	7	8
Computer	10%	7%	83%	100%	20	25	30	3	4	5
Light	15%	10%	75%	100%	287	314	343	65	71	78
Colour TV	10%	7%	83%	100%	172	190	210	27	29	32
Other	10%	7%	83%	100%	375	415	458	58	64	71
Total					2,211	2,349	2,508	392	419	450
Row Unit										
Heating	14%	22%	64%	100%	13	13	14	3	3	3
Vent	14%	22%	64%	100%	2	2	3	0	0	1
DHW	13%	8%	79%	100%	9	9	10	2	2	2
Cook	11%	7%	82%	100%	5	5	6	1	1	1
Refrig	8%	9%	83%	100%	7	7	7	1	1	1
Freezer	8%	9%	82%	100%	6	5	4	1	1	1
Dish	11%	7%	82%	100%	0	0	0	0	0	0
Washer	14%	5%	81%	100%	0	0	0	0	0	0
Dryer	12%	6%	82%	100%	5	6	6	1	1	1
Micro	13%	7%	81%	100%	2	2	2	0	0	0
Computer	10%	7%	83%	100%	1	1	1	0	0	0
Light	15%	10%	75%	100%	10	12	13	2	3	3
Colour TV	10%	7%	83%	100%	7	8	9	1	1	1
Other	10%	7%	83%	100%	10	11	13	2	2	2
Total					75	82	89	13	15	16
Low Rise Apartment										
Heating	14%	22%	64%	100%	42	45	47	9	9	10
Vent	14%	22%	64%	100%	12	13	15	2	3	3
DHW	13%	8%	79%	100%	9	9	9	2	2	2
Cook	11%	7%	82%	100%	14	16	17	2	3	3
Refrig	8%	9%	83%	100%	24	23	22	3	3	3
Freezer	8%	9%	82%	100%	1	2	2	0	0	0
Dish	11%	7%	82%	100%	1	1	1	0	0	0
Washer	14%	5%	81%	100%	1	1	1	0	0	0
Dryer	12%	6%	82%	100%	8	9	9	1	2	2
Micro	13%	7%	81%	100%	3	4	4	1	1	1
Computer	10%	7%	83%	100%	2	3	3	0	0	0
Light	15%	10%	75%	100%	79	87	95	18	20	22
Colour TV	10%	7%	83%	100%	19	21	23	3	3	4
Other	10%	7%	83%	100%	16	18	20	3	3	3
Total					232	251	269	45	48	52

SEEM: Marbek's Sector Energy End-use Model--Capacity

Reference Case - Interior

Enduse	Annual Energy Distribution				Total (check)	Annual Energy Use (Gwh)-Ref. Case					Average Demand in Winter Peak (MW)				
	Winter Off-Peak			Shoulder		2001	2006	2011	2016	2001	2006	2011	2016		
	Winter Peak														
High Rise Apartment															
Heating	14%	22%	64%	100%	15	17	18	20	3	3	3	4	4	4	
Vent.	14%	22%	64%	100%	4	4	5	5	1	1	1	1	1	1	
DHW	13%	8%	79%	100%	4	4	5	5	1	1	1	1	1	1	
Cook.	11%	7%	82%	100%	5	5	5	6	1	1	1	1	1	1	
Refrig	8%	9%	83%	100%	8	7	7	7	1	1	1	1	1	1	
Freezer	8%	9%	82%	100%	1	1	1	1	0	0	0	0	0	0	
Dish.	11%	7%	82%	100%	0	0	0	1	0	0	0	0	0	0	
Washer	14%	5%	81%	100%	0	0	0	0	0	0	0	0	0	0	
Dryer	12%	6%	82%	100%	3	3	3	3	0	0	1	1	1	1	
Micro	13%	7%	81%	100%	2	2	2	3	0	0	0	0	0	0	
Computer	10%	7%	83%	100%	1	1	1	1	1	0	0	0	0	0	
Light	15%	10%	75%	100%	2	29	32	35	6	6	7	7	8	8	
ColourTV	10%	7%	83%	100%	8	9	10	11	1	1	1	1	2	2	
Other	10%	7%	83%	100%	7	8	8	9	1	1	1	1	1	1	
Total					83	91	99	107	16	17	17	19	21	21	
Mobile/Other															
Heating	14%	22%	64%	100%	77	82	88	94	16	17	17	18	19	19	
Vent.	14%	22%	64%	100%	12	13	15	17	2	2	3	3	3	3	
DHW	13%	8%	79%	100%	85	90	96	102	16	17	17	18	20	20	
Cook.	11%	7%	82%	100%	25	27	29	32	4	5	5	5	5	5	
Refrig	8%	9%	83%	100%	52	49	46	45	7	6	6	6	6	6	
Freezer	8%	9%	82%	100%	7	6	5	4	1	1	1	1	1	1	
Dish.	11%	7%	82%	100%	1	1	1	1	0	0	0	0	0	0	
Washer	14%	5%	81%	100%	2	2	2	2	0	0	0	0	0	0	
Dryer	12%	6%	82%	100%	32	33	34	36	6	6	6	7	7	7	
Micro	13%	7%	81%	100%	9	10	11	12	2	2	2	2	2	2	
Computer	10%	7%	83%	100%	4	5	6	7	1	1	1	1	1	1	
Light	15%	10%	75%	100%	47	51	55	59	11	12	12	12	13	13	
ColourTV	10%	7%	83%	100%	49	53	58	63	8	8	8	9	10	10	
Other	10%	7%	83%	100%	107	117	127	138	17	18	18	20	21	21	
Total					510	540	574	613	90	96	96	102	109	109	
Grand Total															
Heating					573	619	670	726	118	127	127	138	149	149	
Vent.					115	129	143	159	24	26	26	29	33	33	
DHW					281	298	318	339	54	57	57	61	65	65	
Cook.					151	164	179	196	25	27	27	30	33	33	
Refrig.					313	298	289	286	40	38	37	37	37	37	
Freezer					161	143	122	112	21	18	16	16	14	14	
Dish.					14	15	17	19	3	3	3	3	3	3	
Washer					16	16	16	17	3	3	3	3	3	3	
Dryer					190	199	210	222	35	36	36	38	40	40	
Micro					49	54	60	66	10	11	11	12	13	13	
Computer					28	35	42	50	4	5	5	6	8	8	
Light					450	493	538	587	102	112	112	122	133	133	
ColourTV					255	281	310	341	39	39	43	48	53	53	
Other					515	568	626	689	80	88	88	97	106	106	
Grand Total					3,111	3,313	3,539	3,808	556	595	595	639	690	690	

SEEM: Marbek's Sector Energy End-use Model--Capacity

Economic Potential Forecast - Interior

Enduse	Annual Energy Distribution			Total (check)	Annual Energy Use (Gwh)--Ref. Case			Average Demand in Winter Peak (MW)		
	Winter Peak	Winter Off-Peak	Shoulder		2001	2006	2011	2001	2006	2011
SFD/Duplex										
Heating	14%	22%	64%	100%	426	446	470	87	91	97
Vent.	14%	22%	64%	100%	86	90	93	18	19	19
DHW	13%	8%	79%	100%	174	151	151	33	29	29
Cook.	11%	7%	82%	100%	102	111	122	17	19	20
Refrig.	8%	9%	83%	100%	223	180	151	29	23	19
Freezer	8%	9%	82%	100%	146	122	96	19	16	12
Dish.	11%	7%	82%	100%	11	11	12	2	2	2
Washer	14%	5%	81%	100%	12	11	10	2	2	2
Dryer	12%	6%	82%	100%	142	149	157	26	27	29
Micro.	13%	7%	81%	100%	33	36	40	6	7	8
Computer	10%	7%	83%	100%	20	12	14	3	2	2
Light.	15%	10%	75%	100%	287	154	170	65	35	39
Colour TV	10%	7%	83%	100%	172	177	183	27	27	28
Other	10%	7%	83%	100%	375	390	408	58	60	63
0	0%	0%	100%	100%						
Total					2,211	2,041	2,078	392	359	369
Row Unit										
Heating	14%	22%	64%	100%	13	12	12	3	3	3
Vent.	14%	22%	64%	100%	2	2	3	0	0	1
DHW	13%	8%	79%	100%	9	8	8	2	1	1
Cook.	11%	7%	82%	100%	5	5	6	1	1	1
Refrig.	8%	9%	83%	100%	7	6	5	1	1	1
Freezer	8%	9%	82%	100%	6	5	4	1	1	0
Dish.	11%	7%	82%	100%	0	0	0	0	0	0
Washer	14%	5%	81%	100%	0	0	0	0	0	0
Dryer	12%	6%	82%	100%	5	6	6	1	1	1
Micro.	13%	7%	81%	100%	2	2	2	0	0	0
Computer	10%	7%	83%	100%	1	1	1	0	0	0
Light.	15%	10%	75%	100%	10	6	6	2	1	1
Colour TV	10%	7%	83%	100%	7	7	8	1	1	1
Other	10%	7%	83%	100%	10	11	11	2	2	2
Total					75	70	73	13	12	13
Low Rise Apartment										
Heating	14%	22%	64%	100%	42	44	46	9	9	9
Vent.	14%	22%	64%	100%	12	13	15	2	3	3
DHW	13%	8%	79%	100%	13	8	7	2	1	1
Cook.	11%	7%	82%	100%	14	16	17	2	3	3
Refrig.	8%	9%	83%	100%	24	21	20	3	3	3
Freezer	8%	9%	82%	100%	1	1	1	0	0	0
Dish.	11%	7%	82%	100%	1	1	1	0	0	0
Washer	14%	5%	81%	100%	1	1	1	0	0	0
Dryer	12%	6%	82%	100%	8	9	9	1	2	2
Micro.	13%	7%	81%	100%	3	4	4	1	1	1
Computer	10%	7%	83%	100%	2	1	1	0	0	0
Light.	15%	10%	75%	100%	79	56	64	18	13	14
Colour TV	10%	7%	83%	100%	19	20	20	3	3	3
Other	10%	7%	83%	100%	16	17	18	3	3	3
Total					232	214	224	45	41	43

SEEM: Marbek's Sector Energy End-use Model--Capacity

Economic Potential Forecast - Interior

Enduse	Annual Energy Distribution			Annual Energy Use (Gwh)--Ref. Case		Average Demand in Winter Peak (MW)			
	Winter Peak	Winter Off-Peak	Shoulder	Total (check)	2001	2006	2011	2016	2016
High Rise Apartment									
Heating	14%	22%	64%	100%	15	17	18	19	4
Vent.	14%	22%	64%	100%	4	4	5	5	1
DHW	13%	8%	79%	100%	4	4	4	4	1
Cook.	11%	7%	82%	100%	5	5	5	5	1
Refrig.	8%	9%	83%	100%	8	7	6	6	1
Freezer	8%	9%	82%	100%	1	1	1	1	0
Dish.	11%	7%	82%	100%	0	0	0	0	0
Washer	14%	5%	81%	100%	0	0	0	0	0
Dryer	12%	6%	82%	100%	3	3	3	3	1
Micro.	13%	7%	81%	100%	2	2	2	2	1
Computer	10%	7%	83%	100%	1	0	0	1	0
Light.	15%	10%	75%	100%	27	20	22	24	5
Colour TV	10%	7%	83%	100%	8	8	8	9	1
Other	10%	7%	83%	100%	7	7	7	8	1
Total					83	78	82	87	17
Mobile/Other									
Heating	14%	22%	64%	100%	77	82	88	95	19
Vent.	14%	22%	64%	100%	12	13	15	17	3
DHW	13%	8%	79%	100%	85	75	75	76	14
Cook.	11%	7%	82%	100%	25	27	29	32	5
Refrig.	8%	9%	83%	100%	52	41	34	29	4
Freezer	8%	9%	82%	100%	7	6	4	4	1
Dish.	11%	7%	82%	100%	1	1	1	1	0
Washer	14%	5%	81%	100%	2	2	2	2	0
Dryer	12%	6%	82%	100%	32	33	34	36	6
Micro.	13%	7%	81%	100%	9	10	11	12	2
Computer	10%	7%	83%	100%	4	2	3	3	1
Light.	15%	10%	75%	100%	47	24	26	28	6
Colour TV	10%	7%	83%	100%	49	49	50	51	8
Other	10%	7%	83%	100%	107	110	114	118	18
Total					510	477	487	503	89
Total									
Heating					573	601	634	673	138
Vent.					115	123	131	138	28
DHW					281	245	244	250	47
Cook.					151	164	179	196	33
Refrig.					313	256	217	192	25
Freezer					161	135	106	90	12
Dish.					14	15	16	17	3
Washer					16	14	13	11	2
Dryer					190	199	210	222	38
Micro.					49	54	60	66	10
Computer					28	17	20	23	4
Light.					450	261	287	316	65
Colour TV					255	262	269	276	40
Other					515	535	558	586	86
Grand Total					3,111	2,881	2,943	3,055	549

SEEM: Marbek's Sector Energy End-use Model--Capacity

Reference Case - Total

Enduse	Annual Energy Use (Gwh)--Ref. Case				Average Demand in Winter Peak (MW)			
	2001	2006	2011	2016	2001	2006	2011	2016
SFD/Duplex								
Heating	2,414	2,602	2,841	3,104	414	447	487	532
Vent.	372	410	454	503	66	73	80	89
DHW	771	816	873	937	148	157	168	180
Cook.	503	539	582	630	84	90	97	105
Refrig.	952	888	851	834	122	114	109	107
Freezer	526	460	386	350	67	59	50	45
Dish.	57	60	64	70	9	10	11	12
Washer	57	57	57	59	12	12	12	12
Dryer	674	693	721	758	122	126	131	137
Micro.	141	153	167	183	27	30	32	35
Computer	103	128	149	178	16	20	23	27
Light.	1,374	1,473	1,590	1,718	312	334	361	390
Other	1,701	1,844	2,026	2,220	263	285	313	343
Total	10,434	10,979	11,695	12,563	1,784	1,886	2,017	2,172
Row Unit								
Heating	177	195	216	239	30	33	37	41
Vent.	23	30	38	47	4	5	6	8
DHW	92	99	106	114	18	19	20	22
Cook.	58	66	76	87	10	11	13	15
Refrig.	105	103	105	110	13	13	13	14
Freezer	42	38	34	33	5	5	4	4
Dish.	6	6	7	9	1	1	1	1
Washer	6	6	6	7	1	1	1	1
Dryer	74	80	88	98	13	15	16	18
Micro.	18	20	23	27	3	4	5	5
Computer	12	15	19	24	2	2	3	4
Light.	139	160	184	213	32	36	42	48
ColourTV	92	106	122	141	14	16	19	22
Other	144	165	191	221	22	26	29	34
Total	988	1,091	1,215	1,372	169	188	210	238
Low Rise Apartment								
Heating	277	299	325	355	48	52	56	61
Vent.	91	101	113	125	16	18	20	22
DHW	82	86	91	97	16	17	18	19
Cook.	112	123	136	151	19	21	23	25
Refrig.	184	178	177	177	24	23	23	23
Freezer	12	13	14	15	2	2	2	2
Dish.	8	9	11	13	1	2	2	2
Washer	7	7	7	7	1	1	1	1
Dryer	72	76	81	88	13	14	15	16
Micro.	46	51	57	63	9	10	11	12
Computer	23	29	35	43	4	5	5	7
Light.	618	680	749	825	140	154	170	187
ColourTV	156	174	193	215	24	27	30	33
Other	147	163	182	202	23	25	28	31
Total	1,835	1,990	2,171	2,378	339	368	403	442

SEEM: Marbek's Sector Energy End-use Model--Capacity

Reference Case - Total

Enduse	Annual Energy Use (Gwh)--Ref. Case					Average Demand in Winter Peak (MW)				
	2001	2006	2011	2016	2016	2001	2006	2011	2016	2016
High Rise Apartment										
Heating	134	148	165	184	184	23	23	26	29	32
Vent.	44	49	55	62	62	8	8	7	9	11
DHW	36	36	38	41	41	6	6	7	7	8
Cook.	50	55	62	69	69	8	8	9	10	11
Refrig.	82	79	79	80	80	10	10	10	10	10
Freezer	7	8	9	10	10	1	1	1	1	1
Dish.	3	4	5	6	6	1	1	1	1	1
Washer	3	3	3	3	3	1	1	1	1	1
Dryer	32	34	37	40	40	6	6	7	7	7
Micro.	21	24	27	30	30	4	4	5	5	6
Computer	10	13	16	20	20	2	2	2	2	3
Light.	346	384	427	473	473	79	87	97	107	107
ColourTV	84	94	106	118	118	13	13	15	16	18
Other	100	112	125	141	141	15	15	17	19	22
Total	950	1,045	1,153	1,275	1,275	177	195	215	215	238
Mobile/Other										
Heating	209	221	237	254	254	38	40	43	46	46
Vent.	21	24	27	30	30	4	4	5	6	6
DHW	185	195	208	221	221	36	38	40	42	42
Cook.	51	54	59	63	63	8	9	10	11	11
Refrig.	102	96	91	88	88	13	12	12	11	11
Freezer	31	27	23	20	20	4	4	3	3	3
Dish.	3	3	3	3	3	1	1	1	1	1
Washer	5	5	5	5	5	1	1	1	1	1
Dryer	66	68	70	73	73	12	12	13	13	13
Micro.	18	19	21	23	23	3	4	4	4	4
Computer	7	9	10	12	12	1	1	2	2	2
Light.	93	100	107	115	115	21	23	24	26	26
ColourTV	89	96	104	113	113	14	15	16	17	17
Other	253	273	297	322	322	39	42	46	50	50
Total	1,134	1,191	1,263	1,344	1,344	195	205	218	233	233
Total										
Heating	3,211	3,466	3,784	4,136	4,136	554	598	652	712	712
Vent.	550	614	686	767	767	97	108	121	135	135
DHW	1,165	1,232	1,316	1,411	1,411	224	236	253	271	271
Cook.	774	838	915	1,000	1,000	129	140	152	167	167
Refrig.	1,425	1,344	1,303	1,290	1,290	183	172	167	165	165
Freezer	620	547	466	429	429	79	70	60	55	55
Dish.	76	83	90	100	100	13	14	15	17	17
Washer	77	77	78	81	81	16	16	16	17	17
Dryer	919	952	997	1,057	1,057	167	173	181	192	192
Micro.	244	267	295	325	325	47	52	57	63	63
Computer	155	195	230	277	277	24	30	35	43	43
Light.	2,570	2,797	3,057	3,344	3,344	583	635	694	759	759
ColourTV	1,211	1,326	1,459	1,607	1,607	187	205	225	248	248
Other	2,344	2,558	2,821	3,106	3,106	362	395	436	480	480
Grand Total	15,342	16,296	17,497	18,931	18,931	2,664	2,843	3,064	3,323	3,323

Enduse	Annual Energy Use (Gwh)--Ref. Case				Average Demand in Winter Peak (MW)			
	2001	2006	2011	2016	2001	2006	2011	2016
SFD/Duplex								
Heating	2,414	2,504	2,632	2,785	414	430	453	479
Vent.	372	385	398	409	66	68	70	72
DHW	771	666	667	687	148	128	128	132
Cook.	503	539	582	630	84	90	97	105
Refrig.	952	756	626	543	122	97	80	70
Freezer	526	434	337	280	56	56	43	36
Dish.	57	58	60	64	9	10	10	11
Washer	57	52	46	38	12	11	9	8
Dryer	874	693	721	758	122	126	131	137
Micro.	141	153	167	183	27	30	32	35
Computer	103	60	70	83	16	9	11	13
Light.	1,374	722	786	858	312	164	178	195
ColourTV	790	798	811	826	122	123	125	127
Other	1,701	1,735	1,805	1,887	263	268	279	291
Total	10,434	9,555	9,708	10,032	1,784	1,608	1,647	1,712
Row Unit								
Heating	177	187	200	218	30	32	34	37
Vent.	23	38	47	47	4	5	6	8
DHW	92	81	82	85	18	16	16	16
Cook.	58	66	76	87	10	11	13	15
Refrig.	105	87	76	72	13	11	10	9
Freezer	42	36	30	26	5	5	4	3
Dish.	6	6	7	8	1	1	1	1
Washer	6	5	5	4	1	1	1	1
Dryer	74	80	88	98	13	15	16	18
Micro.	18	20	23	27	3	4	5	5
Computer	12	7	9	11	2	1	1	2
Light	139	76	87	101	32	17	20	23
ColourTV	92	99	106	114	14	15	16	18
Other	144	155	170	188	22	24	26	29
Total	988	936	997	1,088	169	158	169	185
Low Rise Apartment								
Heating	277	295	314	335	48	51	54	58
Vent.	91	101	113	125	16	18	20	22
DHW	82	72	72	73	16	16	14	14
Cook.	112	123	136	151	19	21	23	25
Refrig.	184	167	156	150	21	21	20	19
Freezer	12	12	12	12	2	2	2	2
Dish.	8	9	10	12	1	1	2	2
Washer	7	6	5	5	1	1	1	1
Dryer	72	76	81	83	13	14	15	16
Micro.	46	51	57	63	9	10	11	12
Computer	23	14	16	20	4	3	3	3
Light	618	456	504	557	140	104	114	126
ColourTV	156	162	168	174	24	25	26	27
Other	147	154	162	172	23	24	25	27
Total	1,835	1,698	1,805	1,937	339	307	328	354

Enduse	Annual Energy Use (Gwh)-Ref. Case				Average Demand in Winter Peak (MW)			
	2001	2006	2011	2016	2001	2006	2011	2016
High Rise Apartment								
Heating	134	145	157	170	23	25	27	29
Vent.	44	49	55	62	8	8	9	11
DHW	34	30	30	31	6	6	6	6
Cook.	50	55	62	69	8	9	10	11
Refrig.	82	74	70	68	10	10	9	9
Freezer	7	7	7	7	1	1	1	1
Dish.	3	4	4	5	1	1	1	1
Washer	3	3	2	2	1	1	1	0
Dryer	32	34	37	40	6	6	7	7
Micro.	21	24	27	30	4	5	5	6
Computer	10	6	7	9	2	1	1	1
Light	346	266	295	329	79	60	67	75
ColourTV	84	88	92	96	13	14	14	15
Other	100	105	112	120	15	16	17	18
Total	950	891	957	1,037	177	162	175	191
Mobile/Other								
Heating	209	220	235	251	38	40	42	45
Vent.	21	24	27	30	4	4	5	6
DHW	185	162	162	165	36	31	31	32
Cook	51	54	59	63	8	9	10	11
Refrig.	102	82	67	58	13	10	9	7
Freezer	31	26	20	16	4	3	3	2
Dish	3	3	3	3	1	1	1	1
Washer	5	5	4	3	1	1	1	1
Dryer	66	68	70	73	12	12	13	13
Micro.	18	19	21	23	3	4	4	4
Computer	7	4	5	6	1	1	1	1
Light	93	46	50	55	21	11	11	12
ColourTV	89	90	91	92	14	14	14	14
Other	253	258	265	274	39	40	41	42
Total	1,134	1,061	1,079	1,112	195	181	185	191
Total								
Heating	3,211	3,352	3,538	3,759	554	579	611	649
Vent.	550	589	630	673	97	104	111	118
DHW	1,165	1,012	1,012	1,042	224	194	194	200
Cook.	774	838	915	1,000	129	140	152	167
Refrig.	1,425	1,165	995	890	183	149	127	114
Freezer	620	515	406	343	79	66	52	44
Dish	76	80	85	91	13	13	14	15
Washer	77	70	63	52	16	14	13	11
Dryer	919	952	997	1,057	167	173	181	192
Micro	244	267	295	325	47	52	57	63
Computer	155	91	108	130	24	14	17	20
Light	2,570	1,566	1,723	1,900	583	355	391	431
ColourTV	1,211	1,236	1,268	1,302	187	191	196	201
Other	2,344	2,406	2,514	2,640	362	371	388	408
Grand Total	15,342	14,141	14,546	15,206	2,664	2,415	2,504	2,633

